U.S. Army Research Institute for the Behavioral and Social Sciences

Research Report 1853

A Near Term Approach to Embedded Training: Battle Command Visualization 101

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14. ABSTRACT *(Maximum 200 words)*:

Design and development of embedded training (ET) has been hampered by technical barriers and a lack of viable training product exemplars. This report describes an innovative training product developed to complement the Army's ongoing ET efforts for the Future Force and provide realistic training solutions for the Current Force wherever deployed. An exemplar product called Battle Command Visualization (BCV) 101 was developed to train many of the basic skills required for employing networked sensors to "see" the battlefield by completing a set of progressive and gated skill development and reinforcement exercises. Expert performance of the exercises on a prototype command and control (C^2) system linked to virtual simulation was recorded to generate high-fidelity source materials for interactive multimedia instruction (IMI) at IMI Levels 1 and 2. The source materials were augmented by teaching points, tactical and reference materials, and quizzes. A surrogate learning management system was developed to control exercise sequence, interaction, quiz administration, training feedback, and remediation. Limited formative evaluation was also conducted. The primary finding of the research is an innovative approach to training that markedly extends Army's ability to deliver the high-fidelity training required by the Current and Future Force.

15. SUBJECT TERMS

Embedded training · Visualization training · Interactive multimedia instruction · Human performance · Progressive exercises · Gate tests · Learning management system · Training fidelity

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Personnel Performance
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A NEAR TERM APPROACH TO EMBEDDED TRAINING: BATTLE COMMAND VISUALIZATION 101

EXECUTIVE SUMMARY

Research Requirement:

In support of future training requirements, the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) conducted a research effort titled *Battle Command Visualization (BCV) 101*. In earlier research (Lickteig, Heiden, & Holden, 2004), ARI developed a series of highly interactive simulation exercises designed to be performed on a prototype command and control (C^2) system linked to virtual simulation. Although technical limitations of the simulation system precluded full implementation of the exercises, numerous lessons were learned for developing near term approaches to embedded training (ET) and future ET designs. The research and development reported here was based on those lessons learned, and focused on building realistic exemplars of ET in the form of exercises that incorporate both interactive multimedia and progressive gated exercises. Realistic exemplars of ET have two important purposes: the innovative training methods can be applied directly to current training needs; and, the overall approach to high-fidelity training provides a working example for research and development on ET for Future Combat Systems (FCS).

Procedure:

The performance analysis for the earlier project (Lickteig et al, 2004) was the starting point for deriving training objectives for this effort. Because the prototype C^2 simulation system did not support structured training with automated feedback, the decision was made to prepare exercises that could be conducted in a web browser supported system, such as a personal computer (PC). The features identified for the training approach included graduated interactivity, progression from procedural to more complex requirements, and interspersed criterion tests, or gates. These features permitted application of four training principles: guidance, control, feedback, and assessment.

The tactical scenario for the exercises is presented by means of a set of Priority Intelligence Requirements (PIR) focused on limited reconnaissance and surveillance (R&S) objectives within an overall tactical mission. The exercise progression, modeled loosely on the Conduct of Fire Trainer (COFT) training matrix, was derived from "chunking" training objectives into five training modules of increasing complexity. Within each module, the exercises are interspersed with gate exercises. If participants do not demonstrate achievement of the training objective on the gates, exercise controls lead back to previous exercises.

Design of a training delivery system to manage exercise presentation and sequencing, participant responses, feedback, and data collection was driven by both technical training capabilities and constraints. The training approach followed the Army's Interactive Multimedia Instruction (IMI) model: observing expert demonstrations of sensor tasks nested in a tactical framework (IMI Level 1); performing highly structured similar tasks with simulation-based

feedback and automated coaching (IMI Level 2); and, performing more free play tasks through hands-on interaction with a C^2 system linked to simulation (IMI Level 3). Construction of the IMI Levels 1 and 2 exercises required the researchers to capture data and images of the expert using the prototype C^2 simulation system and manipulate those data and images using a variety of off-the-shelf software packages for delivery through a standard web browser interface. A learning management system to control the sequence of exercises and the feedback and remediation features was also developed.

The resulting exercises (a total of 94) begin with supporting procedural steps and proceed to more conceptual requirements for visualization. Throughout the development process, ongoing formative evaluation (FE) was conducted by the research team to test and refine linkages, screen layouts, and other features of the design. A limited FE with other training and military subject matter experts was conducted to gather data about the exercises, the training approach, and the expected utility of the exercises for training on a future C^2 system.

Findings:

The primary finding of the research is an innovative training approach that extends the delivery of high-fidelity training; it is not the BCV 101 training product per se. In fact, the FCS sensor and C^2 systems as well as the ET addressed in the training of BCV 101 do not yet exist, and will not for quite some time. Rather, the research proactively designed and developed an ET exemplar with particular relevance to FCS. The training requirement addressed by the research is how to train the tactical and technical complexity introduced by FCS that requires, to the extent possible, train as you fight fidelity.

The BCV 101 approach markedly increases the Army's ability to deliver high-fidelity training at IMI Levels 1 and 2. It creates and packages more realistic training for essentially unlimited computer-based or web-based delivery. As a result, the BCV 101 approach provides an important complement to ET that readily extends to a wide range of conceptual and procedural skill training requirements. And quite unlike the ET of the future, today the BCV 101 approach can be readily adapted to deliver high-fidelity training on computers at home, at home station, or onboard operational systems of the Current Force wherever deployed.

Utilization and Dissemination of Findings:

Results of the BCV 101 were briefed to Program Manager for Future Combat Systems Command and Control (FCS C2), to representatives of the Training and Doctrine Command (TRADOC), to the Integrated Product Team (IPT) Lead for FCS, to the Program Manager for Future Force Simulation, and to representatives of the American Psychological Association's Division 19.

The BCV 101 training product demonstrates an innovative high-fidelity approach to training development and delivery that applies to many of today's Army training requirements. Despite the heralded potential of ET, complementary training methods like the BCV 101 approach will be needed to train the tactical and technical skills that are hard to acquire and increasingly critical to both the Current and Future Force.

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A NEAR TERM APPROACH TO EMBEDDED TRAINING: BATTLE COMMAND VISUALIZATION 101

Introduction

Providing embedded training (ET) is a key goal in the U.S. Army's ongoing effort to develop and field Future Combat Systems (FCS). In support of that goal, the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) conducted a training development research effort titled *Battle Command Visualization (BCV) 101.* The purpose of BCV 101 was to investigate innovative training approaches for the Current and Future Force based on anticipated technical capabilities and limitations of both operational systems and training methods. To provide a working example of the subject training approach, BCV 101 focused on training the conceptual and supporting procedural skills needed to use networked sensors to see the battlefield (Lickteig, Heiden, & Holden, 2004).

This report presents an innovative training approach that markedly extends the Army's ability to deliver high-fidelity training anytime and anywhere. To provide a working example of the training approach, a prototype training product was developed to provide realistic training for many of the basic skills required to employ networked sensors and "see" the battlefield. The BCV 101 training approach and product are documented in this report as follows:

- *The Army's Embedded Training Requirement*—describes the context of the U.S. Army's stated requirement for ET.
- *Background*—discusses the major research and development underpinnings for the work, including the early visualization training research[1] to develop the BCV 101 program.
- *Approach*—addresses the developmental processes from analysis to actual production of exercises.
- *BCV 101 Program Description*—contains detailed descriptions of the exercises, with screen shots that illustrate features of the training approach.
- *Formative Evaluation*—describes internal processes for evaluating products and the limited tryout of the exercises.
- *Conclusions*—discusses how the BCV 101 increases the Army's ability to deliver high-fidelity training and provides a complement to ET that extends to a wide range of Army conceptual and procedural skill training requirements.

In addition, the overall BCV 101 approach, methods, lessons learned, and implications are documented and visually illustrated in a companion multi-media product (Fisher, et al., in preparation). The product is intended for training developers, system developers, decision makers, and others involved in the Army's ongoing research and development to combine training theory and technology.

[1] When used in the context of battle command, "visualization" takes on meaning as the core mental process that commanders use in decision-making to determine how to get forces from their current state or position to the end state that represents mission accomplishment (Department of the Army, [DA], 2003c). The first step in the visualization process is to collect information, hence the "101" in BCV 101.

The Army's Embedded Training Requirement

The U.S. Army has a stated requirement for ET for both individual and collective training. The use of ET is, in fact, a central objective in the Army's ongoing effort to develop and field its Future Combat Systems (FCS). The goal is to provide performance-based training embedded in operational systems, including vehicles, command centers, networks, and other FCS components. With ET capabilities, Soldiers, leaders, and staffs will participate in individual and collective training, on everything from basic system operations to complex applications, while seated in the vehicle or command center. Achieving that goal, however, will be a difficult task. For nearly two decades, the Army has mandated that developers consider ET in all Army acquisition programs, yet there have been few, if any, successful ET applications.

In order to be truly embedded, ET environments must be developed in parallel with the operational systems. System developers are willing to do that (they have, in fact, been directed to do it), but to date have been hard-pressed to produce viable working prototypes. In large part, this is because the FCS systems, including the global network, are still under development. It also reflects the fact that there are few exemplars or models that realistically and persuasively demonstrate an ET functionality.

As FCS designers continue their work on defining the array of diverse and interdependent systems that will comprise FCS, researchers in the training community are engaged in sustained efforts to formulate ET solutions that take advantage of those systems and to identify essential additional training features and capabilities. The FCS is proceeding along a path of spiral development, where new capabilities will be integrated into Current Force systems and operations; training solutions must likewise address both near- and longer-term possibilities. With FCS technologies slated for periodic "spin-outs" to the Current Force over the next few years and full FCS capabilities to be achieved by about 2014, it has become a matter of some urgency to be able to design and demonstrate ET approaches and prototypes in the near-term.

Developing realistic approaches to ET now, in advance of FCS fielding, offers two advantages: The methods can be applied directly to current training needs, and the overall approach provides a working example for research and development on ET for FCS. The research and development reported here focused on demonstrating innovative approaches to training that stress training fidelity and availability and serve as realistic exemplars for further ET efforts.

Interactive Multimedia Instruction and Progressive Gated Exercises for Embedded Training

While we have few actual working examples of an ET capability, there is no shortage of models and techniques that can be exploited in designing and developing ET. One approach that offers promise is interactive multimedia instruction (IMI), whether delivered via CD-ROM or the internet, on a personal computer (PC) or personal digital assistant (PDA), or through the computer interface on a simulator or operational system. Documentation for FCS design requirements indicates that IMI will be one of the three critical elements of future ET (the others being simulation and integrated electronic technical manuals, or IETMs).

There is no one IMI system; for the Army, the U.S. Army Training and Doctrine Command (TRADOC) defines IMI as "...computer-based technology, integrating a combination of, but not limited to, text, graphics, animation, sound, and video.... Training applications that leverage IMI technologies are developed in many forms, including tutorials, simulations, virtual reality, expert systems, as well as *'just-in-time' training embedded in performance support systems*" (Department of the Army [DA], 2003b, paragraph 1-4.b; emphasis added). Thus IMI, for the Army as for the larger training and education community, covers a wide array of training approaches. In common are the requirements for some level of interactivity and the use of delivery modes beyond simple paper-based text.

The interactive courseware component of IMI has been embraced in training environments because it combines the interactivity and management features of computer-based training with the benefits of realistic audio and video. As a general term, IMI refers to course materials that use multiple sensory and functional modes for presentation and student responses as a primary means of facilitating instruction and learning. These materials are suitable for use as part of a normal course of instruction, or distribution to operational activities. Frequently, IMI materials will link media that may include, but are not limited to, programmed instruction, videotapes, slides, film, text, graphics, digital audio, animation, and up to full motion video, to enhance the learning process. While IMI products can range from very simple to highly complex training tools, the generally accepted differentiation among levels of interactivity, adopted by TRADOC (DA, 2003b), is as shown in Table 1.

In addition to the interactivity features of computerized training, IMI courseware applications can support the collection of both qualitative and quantitative data on participant interactions with the training system. Quantitative data can show selections made, number of iterations for success, and the like, that support usage feedback and training assessment. Qualitative data are useful for both performance feedback to participants and content feedback to developers to improve the quality of materials presented in the future (DA, 2003b).

Another instructional model that may be useful in designing exercises for ET is the progressive exercise approach used in the Army's Conduct of Fire Trainers (COFT). The COFT is a gunnery simulator in which two participants (gunner and vehicle commander) train together on target acquisition and firing in a realistic engagement environment. The exercise sequence begins with simple performance requirements and proceeds through increasingly difficult requirements. Test exercises, referred to as "gates," are used to assess proficiency at set points in the progression. Most of the exercises are fairly short (2 to 5 minutes), and both process and outcome are measured.

The COFT exercise matrix is focused on gunnery. While there is no doubt that gunnery involves considerable skill, the activities are largely procedural. Yet there is much about the COFT model that coupled with IMI features should apply to training more conceptual skills. As with the COFT exercises, the BCV 101 training approach applies a progression of increasing difficulty to train conceptual skills. The progression begins with basic instruction in a passive participation mode, adds procedural skill-building with limited participation, then introduces complex conceptual skills with more unprompted participation, and finally provides culminating

practice opportunities with real-time participation. Gate exercises are used to provide checks on learning and skill acquisition before presenting more difficult exercises.

Table 1

Definitions of Levels of Interactive Multimedia Instruction

Interactivity Levels
Level 1 – Passive participation (low simulation presentation). Normally a knowledge, or familiarization lesson, provided in a linear format (one idea after another). Primarily used for introducing an idea or concept. The user has little or no control over the sequence and timed events of the lesson material. Minimal interactivity is provided by selective screen icons. Commonly called 'a page turner.'
Level 2 – Limited participation (medium simulation presentation). Involves the recall of more information than Level 1, and allows the user more control over the lesson's scenario through screen icons and other peripherals. Typically used for lessons covering noncomplex operations and maintenance. Extensive use of remediation to reinforce the learning objectives. Simple branching may be used, permitting the user to veer from the main instructional path to seek additional information. Instruction is essentially linear. At its most rudimentary, Level 2 presents a choice or question, and after student interaction, immediately provides 'the correct solution,' or additional information.
Level 3 - Complex participation (high simulation presentation). Involves the recall of more complex information (compared to Levels 1 and 2), and allows the user an increased level of control over the lesson scenario. Involves applying information, even complex information, to solving a problem or producing a result. Prompting is much reduced. Emulation and simulation are used as an integral part of equipment operation and maintenance, along with extensive use of peripherals. Multiple branching provides more realism. Remediation, if any, occurs at the end of an instructional block, or at an important learning point (i.e., 'go/no go' condition). Instructional sequence is only vaguely linear—the user moving from a start point to an end point; but because of the multiple branching feature, the user is able to progress using any of multiple paths.
Level 4 – Real-time participation (real-time simulation presentation). Involves more in-depth recall of a larger amount of information (compared to lower levels), and allows the user an increased level of control over the lesson. Every possible subtask is analyzed and presented with full, on-screen interaction, similar to the approach used in aircraft simulator technology. Lesson material is extremely complex, and involves more frequent use of peripherals, to affect the transfer of learning. Users prove they can perform specific tasks, errors are compounded, training prompts do not occur, and feedback occurs after the user passes or fails. Remediation only at end of lesson.

Note: Adapted from TRADOC Regulation 350-70-2 (DA, 2003b, paragraph 1-5).

Because of the capability for including visual enhancements, IMI products that incorporate features of the COFT model appear to be particularly valuable where performance depends on visual detection and identification. An IMI product delivered via an ET capability could offer the participant a view of an operational system interface with visual enhancement add-ons, reference materials, and directions to conduct coaching and feedback about

performance of certain tasks (Department of Defense [DoD], 1999). It could even allow use of actual system controls in responding to or manipulating instructional content. Additionally, both TRADOC's IMI descriptions and FCS documentation link IMI and ET: ET for FCS will include IMI materials as one of the three components, and ET is cited as one of the logical delivery systems for IMI-based training (FCS-LSI, Force Development, Build and Sustain, in preparation).

Sensors and Visualization for Future Forces

The decision to conduct research on a BCV 101 training program was prompted by consideration of the operational expectations for Soldiers manning Future Force combat vehicles and other systems for the U.S. Army.[2] The ongoing transformation of battlefield systems posits a virtual fusion of humans and computers into a hybrid-networked system for command, control, and communications. This alliance of manned modules and (initially) semi-autonomous ground and air platforms will form a coherent, seamless, tactical force for mission accomplishment. Soldiers will be equipped with and trained to use sensors and beyond-line-of-sight weapons capabilities to attack and defeat enemy targets.

The vision for transformation encompasses not only systems, but also operations. Future Force units equipped with FCS will deploy rapidly, engaging in entry and follow-on operations. Units at every level will be tactically employed in full-spectrum missions and will operate well beyond the capabilities of potential foes. As described in the Army's Field Manual (FM) 6-0, *Mission Command,* the Future Force concept of visualization is related directly to familiar concepts of reconnaissance and force protection in that it emphasizes the processes of discovering information about the enemy and shielding friendly information from the enemy while developing the situation out of contact (DA, 2003c).

The ability to integrate the raw data flowing into a command and control (C^2) system with information already acquired to construct a coherent common operating picture has long been a critical requirement for commanders. For the Future Force, commanders at all levels down to the company will have greater access to all collection sources on the battlefield. As commanders with Current Force expertise enter Future Force organizational structures, they will adapt familiar methods and procedures to exploit the new capabilities. The start-point of the operational planning-execution cycle for Future Forces is described as follows:

> During operations, commanders first *observe* the situation—that is, they collect information. They learn about the status of their own forces, the environment, and the enemy through intelligence, surveillance, reconnaissance, information systems (INFOSYS), and reports from other headquarters. Sometimes they actively seek information; sometimes the command and control (C^2) system disseminates it to them (DA, 2003c, p. A-1).

Other TRADOC guidance for the Future Force (DA, 2002) also discusses visualization requirements. Future Force units, using the networked, cooperative sensors within the joint operational environment, will see the enemy as a whole complex and adaptive organization.

[2] Background information is drawn from Lickteig et al., 2004.

Commanders will have the ability to examine and follow up on any particular input into the C^2 system for their own purposes in order to gain critical information affecting an immediate decision. Parallel analyses will be conducted by higher, lower, adjacent, and supporting commanders working to identify critical enemy decisions or actions that indicate a particular enemy course of action. The data and conclusions will be mutually informing and supporting, allowing for a rich and accurate common operational picture that assists commanders in understanding what the enemy is currently doing and may do next.

A vital contributor to achieving full visualization capabilities will be the system of networked air and ground sensor platforms, particularly unmanned platforms. Unmanned systems will increasingly provide small unit commanders with reports, snapshots, and live video outputs of battlefield conditions. Such sensors include unmanned aerial vehicle (UAV) sensors, micro-UAVs (mUAV) that are designed for use in urban areas and close terrain; and the prototype unmanned ground vehicle (UGV) sensor, the Robo-Scout. They will be equipped with both passive and active systems to provide target acquisition, real-time tracking, and identification of entities in the area of operations for the unit. Sensor data and other information will form the basis of commander's ability to make decisions and control manned and robotic units on the battlefield.

One assumption for Future Forces is that every Soldier, not just sensor operators, will understand the capabilities and limitations of the sensor network (ARI, 2003). This basic understanding will enable the use of the sensor network to effectively and efficiently form a common operating picture within the unit. Sensors will achieve a limited degree of information fusion (estimation and prediction of the detected entity's state, but not situation or impact assessment; Scherl & Ulery, 2004), but multi-skilled warfighters, including small unit command groups, will need to gather and analyze data from multiple sensors, turning it into information organized in a coherent and immediately comprehensible operational picture. They will be supported by a repository of information, accessed by means of a "reach" capability (i.e., access to additional information) enabled by the command network. The requisite technical and tactical skills of the Future Force command group will have to be found at every echelon, allowing full and immediate exploitation of every advantage on the battlefield.

Developing training that will support skill acquisition and sustainment and delivering that training when and where it is needed are the challenges. For visualization, the training to operate the systems—to deploy the sensors and capture feeds from those sensors—is relatively straightforward; such operator training is not intrinsically different from training to operate weapons or vehicles, which the Army has been doing successfully for many years. Visualization, however, is multifaceted and requires a high degree of conceptual understanding and interpretation. The challenge will be to train skills of understanding, appreciating, and exploiting capabilities, analyzing and interpreting input from multiple sources, obtaining additional information as needed by means of the reach capability, and using the fused data to answer key intelligence requirements. This training, too, must be deliverable in a wide variety of settings, to command group personnel at every level.

Prior Research on Sensors and Visualization Training

In a series of exploratory experiments on Future Force organizations and equipment, the U.S. Army's Communications-Electronics Command (CECOM) at Fort Monmouth and the Defense Advanced Research Projects Agency (DARPA) worked together to investigate how sensors, particularly unmanned aerial sensors, would support C^2 on the battlefield (Lickteig, Sanders, Durlach, Lussier, & Carnahan, 2003). The virtual simulation for this research represented a Future Force environment for a notional small unit (company-level) command group equipped with FCS.

The training requirements for participants in the experiments involved establishing familiarity and basic skill with highly automated and interdependent network-based systems (Lickteig et al., 2003). For new participants in the FCS C^2 program, introductory training and practice on operating the C^2 system user interface took two weeks, followed by a one-week experimentation period.

This introductory training began with a lecture-based non-interactive slide show primer with graphic depictions of weapon and sensor systems, including individual sensor coverage and outcomes, and description of the reach capability. Depictions of this type showing idealized results offer excellent information, but little opportunity for participants to assimilate the skills and interactions associated with the array of networked, organic, and external sensors required for their missions. Once Soldiers were trained on the use of the C^2 interface itself and had practiced with overlays, files, reach, and various other menu-driven features, they were expected to engage in fairly high-level simulation-based training using actual system features.

Lessons learned from the FCS C^2 experiments centered on the difficulties that even experienced participants had in mastering the technical and tactical aspects of individual and networked sensors. For example, participants were frequently unable to recognize and identify individual elements in the enemy array. This array included a large number of vehicle types along with dismounted infantry. Even when the participants were initially proficient, they soon became overwhelmed by the mass of data from the sensors. They sometimes lost track of individual threat entities and were unable to assemble and visualize an accurate common operating picture. Similar shortcomings in battlefield visualization and associated skills of Soldiers and leaders had been identified several years ago, most pointedly at the commander and staff levels (Reilly, 1997; Solick, 1997).

Providing information is an essential component in developing expertise, but it is not the only component. After knowledge acquisition comes highly structured, guided training with feedback, followed by practice opportunities in increasingly complex settings. Observers of FCS C^2 training suggested that the C^2 system and interface could be adapted to introduce, familiarize, and train multiple aspects of sensor employment and exploitation. Whether or not it could in fact be adapted was unknown, but the notion of using a simulated operational C^2 system to support training on that system closely parallels expectations for Future Force embedded training (DA, 2003a; Throne & Burnside, 2003).

Prior Research on BCV 101

The system complexity and training shortcomings observed during the FCS C^2 experiments underscored the need for ET research and exemplars. As a result, the BCV 101 training program was initiated to research innovative training approaches for the Current as well as the Future Force. Notably, key components of the FCS C^2 program, a C^2 system linked to virtual simulation, provided essential elements for exploring ET design and development.

The initial BCV 101 research stressed ET's relation to operational systems by requiring training participants to perform networked sensor exercises using the actual inputs and controls of a C^2 system just as command group participants might perform the same exercises. The C^2 interface is important because the networked nature of FCS will elevate an operational C^2 sub-system to *supra*-system. The C^2 systems link to virtual simulation, namely OneSAF Testbed Baseline (OTB), provided intrinsic feedback on performance by generating accurate models of system and setting interactions (OneSAF Objective System, 2004). Simulation is important because battlefield dynamics, the time and space interactions of operational systems and settings, is essential to seeing and understanding the battlefield.

From the outset, BCV 101 design goals stressed the use of structured training for more conceptual skills modeled after COFT's progressive and gated training for more procedural gunnery skills. The initial BCV 101 research included an analysis of performance requirements for visualization, particularly at the initial skill acquisition stages of training. The focus was on conceptual visualization skills required for battlefield success by the company command group. For that earlier project, a comprehensive performance requirements analysis identified the use of designated UAVs and UGVs as the critical component for battlefield visualization using FCS. Participants needed to learn to use individual and networked sensors to detect enemy targets and predict enemy intentions and actions. "Using sensors," though, turned out to be a complex set of related behaviors.

Operating ground and air sensor platforms requires an understanding of differing sensor capabilities and how they can work together. Coverage depth (distance from the sensor) and coverage fan (also called the sensor fan or range fan) must be factored into the use of the sensors singly, but also in a coordinated fashion that provides overlapping detection. Overlapping detection is achieved through physical ground sweeps and careful timing of observations so that expected changes are detected, and through cross cueing between long range sensors and smaller sensors that provide close observation. Several related concepts were thus identified for the training focus: sensor capabilities, limitations, and vulnerabilities; sensor tasking; dynamic sensor re-tasking; and sensor integration into tactical operations.

During the earlier BCV 101 development work, a structured set of 20 complex, realistic, high quality exercises was developed, requiring FCS company-level command vehicle crewmembers to use remote air and ground sensors to find enemy dispositions on a battlefield. The exercises were all at IMI Level 3 (complex participation, high simulation presentation), and were progressively difficult. They addressed the concepts noted above within the context of a battlefield scenario, leading the participant through five training modules:

(1) Detect stationary targets;

(2) Detect moving/camouflaged targets;

(3) Predict enemy intentions;

(4) Predict enemy actions (basic); and

(5) Predict enemy actions (advanced).

However, because the prototype C^2 system was intended as a simulator for use in battle command experiments and not as a trainer, its functionality was not well-suited for training. For example, the system's complex simulation programming permitted very little automated coaching, feedback, or remediation. Instead, a live coach or observer/controller was required to observe, provide feedback, and direct the learner to repeat exercises as appropriate for remediation. Thus, actual development and implementation of the exercises were only marginally successful. Lessons learned, coupled with the increased emphasis on development of ET, offer opportunities to formulate possible near-term approaches. Prominent among those lessons was the emphasis on realistic, high fidelity presentations coupled with more readily available training delivery systems.

Purpose of the Research

The immediate objective of the effort that is the subject of this report was to develop a structured training program for basic battle command visualization skills. Based on lessons learned, the work focused on visualization training that could be delivered apart from the prototype C^2 system. The emphasis was on retaining as much fidelity as possible while increasing availability. The classic training principles of control, guidance, feedback, and assessment were fundamental to the design.

The design process in this project included exploration of IMI and COFT features, in order to incorporate the best of both into an ET-like prototype with a blend of simulation-derived representations and interactivity. From the COFT model, the principles to be adapted included the progression of complexity and difficulty, opportunity for performance repetition, feedback, and gates. Using IMI Levels 1 and 2, along with notional inclusion of the designed exercises at IMI level 3, the training would provide part task–whole task instructional guidance, explicitly portraying the relationship between exercise content and tactical scenario requirements.

This project originally had two purposes. The resulting training exercises were to be used in preparing participants for FCS C^2 experiments, but more importantly, the development process would yield valuable lessons learned in understanding future operating and training environments. While events in the experiment scheduling precluded use of the product as intended (Lickteig et al., 2004), developing an exemplar of IMI-ET that could guide usage in the Future Force remained a viable and critical goal.

Approach

This section describes a number of design and development considerations and processes associated with the BCV 101 training that was produced in this project. The specific topics, addressed in separate subsections, include:

- Initial decisions regarding the scope of the ET prototype product,
- Formulation of the training objectives,
- Tactical scenario and products created to provide a realistic context,
- Program structure in terms of exercise progression and gate requirements,
- Training delivery method and features, and
- Technical processes required to construct the exercise products and related materials.

The research product is a set of 94 structured exercises arranged in a progression of increasing interactivity and complexity, delivered by means of PC and the prototype C^2 virtual simulation system with OTB. Of those 94, 20 exercises are those developed in the earlier project. The new exercises are less complex than the original 20, but address the same learning objectives. A later section, *BCV 101 Program Description*, presents and illustrates the product.

Initial Decisions

As is recommended in building structured training (Campbell, Campbell, Sanders, Flynn, & Myers, 1998), initial decisions were specified that defined the scope of the exemplar training program. Some of the early decisions for BCV 101 included the following:

- Primary training audience is Company Command Group for FCS Unit of Action.
- Focus is on generic training across the Command Group (i.e., training is not specific to duty positions in the Command Group).
- Design is based on a small representative set of individual and networked sensors and platforms (air and ground).
- Exercises are structured in an integrated tactical framework to relate individual tasks to the "bigger picture" of battle command visualization.
- Design employs IMI Levels 1–3 for each training objective.
- Screens and displays employ perceptual augmentation when possible and appropriate.
- Design stresses training accessibility (usable from classroom to fully embedded).
- Design stresses system fidelity (visual representations of system appearance and functions).
- Design is not limited by currently available hardware and software.

These considerations were particularly important for *design* of the BCV 101 training and were not expected to be translated wholesale into the developed products—some (such as the last one listed above) were logically attainable in design but not in development. In order to keep the emphasis on innovative products, the design process would consider all of these features and incorporate as many as possible.

Training Objectives

Designation of the specific training objectives derived from a number of considerations, including, first and foremost, the performance objectives as delineated in the predecessor BCV 101 development (described earlier and repeated here):

(1) Detect stationary targets;

(2) Detect moving/camouflaged targets;

(3) Predict enemy intentions;

(4) Predict enemy actions (basic); and,

(5) Predict enemy actions (advanced).

While the five training modules titles explicitly state tactical objectives, supporting conceptual objectives were clearly identified within each module (described below). Equally important were the design goals of having a single comprehensive tactical scenario underlying the exercises and building progressively complex exercises.

One premise for the DARPA/CECOM experiments is that participants would enter the training with considerable tactical knowledge and skill, and also with some familiarity in using the C^2 interface (Lickteig et al., 2004). The exercises with IMI Level 1 and 2 interactivity features were designed to be a part of the training that would provide that familiarity. By analyzing the performance requirements for the original 20 exercises and building predecessor exercises focused on providing supporting information and enabling skills, a progressive sequence for training could be generated.

Tactical Scenario and Materials

In order to provide part task–whole task linkages with a continuously realistic thread, an underlying tactical scenario was created. Performance of the BCV 101 exercises occurs within an overall mission of addressing a set of priority intelligence requirements (PIRs) focused on limited reconnaissance and surveillance (R&S) objectives.

The principal tactical product used to bind the scenario was the PIRs. As defined in FM 1-02 (DA, 2004), PIRs are intelligence requirements for which a commander has an anticipated and stated priority in his planning and decision-making. Table 2 shows the PIRs that were formulated to provide the tactical basis for the BCV 101 exercises.

Table 2

Priority Intelligence Requirements

PIR#	BCV 101 Priority Intelligence Requirement (PIR) Statements
1.	Where are the enemy recon vehicles?
2.	Are there combat outposts in the security zone?
3.	Has the enemy emplaced obstacles or other engineer work to channelize the attack?
4.	Where are the main defense vehicle-mounted anti-tank weapons (tank and missile)?
5.	Where is the combined arms reserve or counterattack force?
6.	Where are enemy Non-Line-of-Sight (NLOS) systems (tube and mortar) located?
7.	Are there activities indicating the enemy is preparing to attack, or continuing to defend?

The PIRs focused on battlefield positioning and activities of the enemy forces within a context of friendly operations in a specified area. In order to reflect the FCS emphasis on developing the situation out of contact, the exercise conditions first guide the participant to locate the enemy as early as possible, with sufficient accuracy for weapon targeting. As the tactical situation develops over the course of the exercises, participants then must dynamically task sensor platforms during contact. The PIRs are used to keep the participant focused on conducting actions that reveal or confirm battlefield information and produce updated information to inform the tactical planning and execution based on known enemy actions, positions, or demonstrated intentions.

A second type of tactical product is the R&S overlay (Figure 1). An R&S overlay provides an integrated and coordinated plan for gaining information superiority on the battlefield. Named areas of interest (NAIs) are drawn on overlays to mark the designated areas of terrain that hold battlefield interest to a friendly unit, based on the PIRs.

For the BCV 101 exercises, a single comprehensive overlay for the scenario, with all NAIs already drawn, was produced on the prototype C^2 system and then cut down into five separate "segments" that focus on the terrain area specific to each of the five modules. Versions of the overlays without the NAIs were then prepared, on which the participant learns to draw NAIs during exercises in Module 1. The expert version of the overlay then serves as a performance standard on which feedback to participants is based. The NAIs remain constant throughout all of the BCV 101 modules and exercises, producing an evolving and integrated view of the battlefield in relation to known or suspected stationary enemy units, moving enemy units reported by adjacent friendly units, and areas of potential enemy activity.

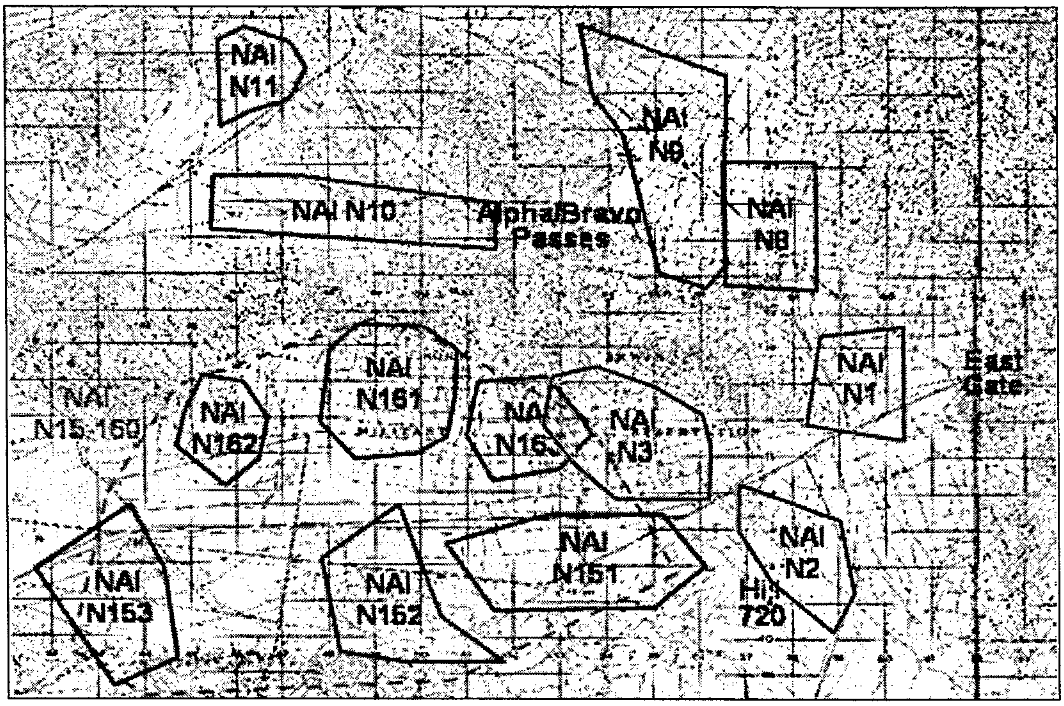

Figure 1. Example of an integrated reconnaissance and surveillance (R&S) overlay to support the mission environment framework for the Battle Command Visualization (BCV) 101 exercises.

A third key tactical product is a modified sensor tasking matrix, shown in Figure 2. This matrix serves as a tool to track actions being taken to address PIRs and record information gathered. In BCV 101, it guides the actions taken by the participants throughout the exercise progression.

As training tools, the PIRs, overlays, and matrix serve as a framework for all exercises and a meaningful context for military users. The matrix permits the participant to see the relationships among PIRs, graphic control measures on the R&S overlay, focused areas of concern for sensor systems, expected enemy systems in the area from a war game of the coming battle, and reporting procedures needed to act on the battlefield information. Together, they are the instantiation of the part task–whole task training feature included in the design plan, showing how exercises are related to an overall plan that provides the participant with a mental model of enemy activity on the battlefield. By having these tools available and embedded in the training system, doctrinal battlefield methods for controlling and directing reconnaissance operations are reinforced.

Decide				Allocate		Trace		Assess	
Priority (PIR #)	Target Type	Location	Confirmed/ Suspected/ Templated	Unit	Platform/ Sensor	Locate or Track	Frequency of Update	Identification Level Required	Inform
1 (PIR 1)	Tracked & Wheeled Vehicles	NAI 1, 2	S, T		S200 synthetic aperture radar (SAR) xcue mUAV 1, 2	L	2 hrs	Vehicle type, grid	Intel, Fires
2 (PIR 2, 3)	Tracked, Wheeled, & Dismounted Infantry Squad	NAI 3	T		mUAV 3	L	4 hrs	Vehicle type, grid, Squad center of mass (CoM)	Intel, Fires
3 (PIR 2, 4)	Tracked & Wheeled Vehicles	NAI 8	S		A160 (SAR), S200 SAR xcue mUAV 1	L	2 hrs	Vehicle type, grid	Intel, Fires
4 (PIR 5)	Tracked Vehicles	NAI 9	S		A160 moving target indicator (MTI), S200 xcue mUAV 2	L, T	5 min	Vehicle type, grid, direction	Intel, Fires, Cdr
	Tracked & Wheeled Vehicles	NAI 10	S		A160 (MTI), S200 xcue mUAV 3	L, T	5 min	Vehicle type, grid, direction	Intel, Fires, Cdr
5 (PIR 6)	Tracked Vehicles	NAI 11	T		A160 (SAR), S200 SAR xcue mUAV 1, UGV 1	L	15 min	Vehicle type, grid	Intel, Fires, Cdr
6 (PIR 3, 4, 5, 7)	Tracked & Wheeled Vehicles	NAI 12x series	S, T		A160, S200 SAR xcue mUAV 1	L	2 hrs	Vehicle type, grid	Intel, Maneuver, Fires
	Tracked, Wheeled, & Dismounted Infantry Squad	NAI 13x series	S, T		S200 SAR xcue mUAV 2, UGV 1	L	2 hrs	Vehicle type, grid, Squad CoM	Intel, Maneuver, Fires
7 (PIR 5, 7)	Tracked & Wheeled Vehicles	NAI 14x series	S		S200 SAR xcue mUAV 3, UGV 2	L	2 hrs	Vehicle type, grid	Intel, Maneuver, Fires
8 (PIR 5, 7)	Tracked & Wheeled Vehicles	NAI 15x series	S		A160, S200 xcue mUAV 1	L, T	5 min	Vehicle type, grid, direction	Intel, Maneuver, Fires, Cdr
9 (PIR 6, 7)	Tracked & Wheeled Vehicles	NAI 15-160, 16x series	S		A160, S200 xcue mUAV 2, UGV 1	L	15 min	Vehicle type, grid	Intel, Fires
10 (PIR 3, 5, 7)	Tracked & Wheeled Vehicles	NAI 17x series	S		A160 (MTI), S200 xcue mUAV 1	L, T	5 min	Vehicle type, grid, direction	Intel, Maneuver, Fires, Cdr
	Wheeled Vehicles	NAI 17-160, 18x series	S		A160 (MTI), S200 xcue mUAV 2, UGV 1	L, T	5 min	Vehicle type, grid, direction	Intel, Maneuver, Fires, Cdr

Figure 2. Completed sensor tasking matrix for Battle Command Visualization (BCV) 101 exercises.

A number of other tactical materials were also created to add realism to the scenario. These include a complete analysis of the area of operations (AO), including a summary description of the operational area, terrain analysis, description of weather and effects on sensors, and description of the enemy situation and enemy courses of action (COA). All of the relevant

tactical products are accessible by the participant during the exercises, replicating the reach capability on the FCS command network.

Three UAVs (the mUAV, the Shadow 200, and the A160-MTI/SAR) and one UGV (the Robo-Scout) were selected for use in the BCV 101 exercises. Primary detection for all platforms is from optical sensors using either daylight or thermal imagery and radar, synthetic aperture radar (SAR), or moving target indicator (MTI) radar. This functional sensor array is both representative of the types of sensors most likely to be used by a company command group and characterized by a wide array of capabilities, and provides a realistic set of conditions for the exercises.

Battle Command Visualization 101 Program Structure

In formulating the structure of the BCV 101 training program in this project, with its combination of IMI and COFT-like features, development was initially based on the previously developed exercises. These 20 exercises were presented using Level 3 interactivity with considerable user control and branching, but little in-progress coaching, feedback, or remediation. The more structured, instructional segments with Level 1 and 2 interactivity provide the basic skills upon which participants build as they begin to understand and appreciate visualization concepts. The training is modular, progressing from the initial introduction of materials that reinforce procedural skills while introducing and then exercising conceptual skills in the participant. As shown in Figure 3, there is a prescribed progression of exercises from Level 1 through Levels 2 and 3 within each module. Participants proceed through the exercises in a way that presents linked instruction and practice across performance requirements of increasing complexity. The exercises lead to and model "*a* solution," based on expert performance. This situation is specifically described in the training introduction. (The user interface, introduction and instructions, cues, controls, and coaching and feedback content are described and illustrated in a later section, *BCV 101 Program Description.*)

Lvl	Module 1. Detect stationary targets														
3[a]								28	29	30	31	32	33	34	**35**
2				16	17	18	19	20	21	22	23	24	25	26	**27**
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	**15**

Lvl	Module 2. Detect moving and camouflaged targets						
3[a]			15	16	17	18	**19**
2	8	9	**10**	11	12	13	**14**
1	1	2	3	4	5	6	7

Lvl	Module 3. Predict enemy intentions					
3[a]			13	14	15	**16**
2	7	8	9	10	11	**12**
1	1	2	3	4	5	**6**

Lvl	Module 4. Predict enemy actions (basic)				
3[a]			9	10	**11**
2	4	5	6	7	**8**
1	1	2	3		

Lvl	Module 5. Predict enemy actions (advanced)				
3[a]	9	10	11	12	**13**
2	4	5	6	7	**8**
1	1	2	**3**		

[a] The Level 3 exercises developed in the earlier BCV 101 project include: Exercises 28-34 in Module 1, 15-18 in Module 2, 13-15 in Module 3, 9-10 in Module 4, and 9-12 in Module 5.

Figure 3. Relationship among modules, levels, exercises, and gates (indicated in shaded cells).

Within each of the five modules, Level 1 exercises give the participant demonstrations of the appropriate actions, nested in the tactical framework, to create elements on the R&S overlay and the R&S tasking matrix. The participant controls progress through the exercise, choosing

either a text description of the required action and an animated demonstration of the steps to complete the action or an autoplay feature that dynamically demonstrates all steps and system responses covered in that exercise.

After successfully completing Level 1 for a module, the participant proceeds to Level 2 for that module. In Level 2 exercises, the participant actually performs most of the same actions that were demonstrated in Level 1, following the same expert sequence of actions to perform the tasks. This reinforces the previous build of the R&S overlay and use of the tasking matrix. Level 2 exercises build on Level 1 exercises, using similar situations and screens with specific "hot" areas, corresponding to a representation of actual C^2 interface controls, where the user must interact (via keyboard or mouse) in order to proceed. Dynamic tips and feedback are built into Level 2 exercises to guide the participant. Simple automated coaching and feedback are presented on the user interface.

For Level 3 exercises, the participant moves to the prototype C^2 system. While these exercises exist and can be conducted, it should be noted again that their high fidelity is paralleled by relatively low availability. That is, they can be conducted only on that simulation system and require the assistance of a live coach for feedback and remediation. In the Level 3 exercises, in an environment that closely emulates the features of future C^2 systems, the participant responds to highly realistic situational cues and performs actions using actual physical and screen-based system controls, rather than a strictly PC-based training interface with representation of the actual C^2 interface.

Within each of the five modules, in addition to the exercises at all three IMI levels, there are gates (checks on learning or quizzes) to verify the participant's understanding of the information and its application. (Level 1 gates are referred to as "Checks on Learning" while Level 2 gates are called "Quizzes" and gates at the end of each module are called "Module Quizzes." The intent was to ease the participant into the evaluative aspect of the program.)

Table 3 shows the relationship between the modules and the tactical requirements as defined by the PIRs, the R&S overlay, and the sensor tasking matrix. The modules proceed systematically to lead the participant to examine the NAIs, but this does not translate into systematically addressing the PIRs. Rather, the participant uses the sensor tasking matrix to determine which PIRs to focus on within each NAI.

Table 4 describes the content of each of the modules, demonstrating the relationships among the exercises and levels. This part task–whole task approach is supported by means of direct portrayal of the overall tactical scenario and the command group tasks within that scenario. Each exercise is clearly linked to the previous exercises, building from use of higher headquarters directives to designating NAIs and Restricted Operating Zones (ROZs), assigning sensors, and tasking them to satisfy PIRs. With the Level 3 exercises, the participant can begin directed development of sensor tactics to maximize survivability and coverage.

Table 3

Relationship between Modules and Tactical Scenario

Module	Location	Priority Intelligence Requirement #
1	Named Area of Interest (NAI) 1, 2	1
	NAI 3	2, 3
2	NAI 8	2, 4
	NAI 9, 10	5
	NAI 11	6
3	NAI 12x, 13x series	3, 4, 5, 7
	NAI 14x series	5, 7
4	NAI 15x series	5, 7
	NAI 15x, 16x series	6, 7
5	NAI 17x, 18x series	3, 5, 7

Training Delivery System

The earlier BCV 101 exercises were designed to run in the prototype C^2 system environment. While that system allowed for the realism of a virtual simulation, it did not permit developers to modify any operating characteristics. As a result, every exercise could run only in real time. Developers could not isolate particular situations or conditions to use as teaching points, and could not insert feedback or coaching capabilities. Additionally, developers could not restrict the amount of interactivity in order to focus on particular objectives. The problem of adding teaching and feedback features to an already developed and implemented product was identified during the previous BCV 101 work (Lickteig et al., 2004).

In the final analysis, the Level 3 exercises were invaluable in providing performance requirements and sensor system analysis products, training design specifications, and lessons learned on building ET-like training, but were not feasible as prototypes of near-term ET. (It should be noted that future ET developers may initially encounter similar difficulties using operational systems for ET incorporating IMI Level 3, complex participation and Level 4, real-time participation.) The prototype C^2 system was not designed for nor capable, without modification, of handling the required processes for training delivery—to control, guide, assess, and provide feedback.

As a result of the analysis of those training barriers, and in consideration of the decision to use IMI Levels 1 and 2 and a COFT-like progression to structure the exercises (as described earlier), it was obvious that a system other than the prototype C^2 simulation environment would be used for training delivery. One widely-available system is the PC, with exercises provided on a memory device such as CD, DVD, or USB memory drive. Developing training for PC delivery also means that the training could be conducted in a classroom, via a PDA, over an intranet or the internet, or even in an operational system—as long as there is a common user interface, such

as a web browser. By electing to use a web browser interface for the IMI Level 1 and 2 exercises, one advantageous outcome is that the exportability and access to the training is assured. This type of Level 1 and 2 IMI training permits delivery at the convenience of the unit leadership. It remained important, however, to ensure that high fidelity would not be sacrificed for convenience or widespread availability—which is not anticipated as a problem for true ET.

Table 4

Battle Command Visualization (BCV) 101 Exercise Descriptions

Module Objective and Conceptual Overview	Level 1 describes and demonstrates how to...	In Level 2, participant performs the steps presented in Level 1 to...	In Level 3, participant uses the prototype C^2 system and acquired skills to...
Module 1: Detect stationary targets. Provides background and underlying conceptual information that builds a foundation for Battle Command Visualization.	Designate a named area of interest (NAI), view NAI integration, and use a restricted operating zone (ROZ); task micro-unmanned aerial vehicle (mUAV) and unmanned ground vehicles (UGV); cross cue sensors and use templates. **Exercises**: 14 + gate **Gate:** NAI, ROZ, cross cueing, templates.	Draw NAI and ROZ, task S200, mUAV, and UGV, demonstrate cross cueing and templating, evaluate sensor outputs. **Exercises**: 11 + gate **Gate**: Sensor capabilities.	Identify vehicles and battle positions (e.g., counter - reconnaissance position, security position). **Exercises**: 7 + gate **Module 1 Quiz**
Module 2: Detect moving/ camouflaged targets. Adds an additional sensor platform, detection of moving targets, evaluating sensor outputs and cross cueing methods, identification of enemy units, and initial attempts to identify enemy intentions.	View the output of cross cueing, task an A160, use the A160 to cross cue other sensors, detect moving targets, evaluate sensor outputs and sensor output differences, and evaluate cross cueing methods. **Exercises**: 7	Track moving targets and evaluate sensor outputs. **Exercises**: 5 + 2 gates **Gates:** Moving target tracking methods, identification of enemy units and probable intentions.	Confirm an enemy position and detect enemy moving and stationary vehicles. **Exercises**: 4 + gate **Module 2 Quiz**
Module 3: Predict enemy intentions. Adds a focus on evaluating and identifying sensor outputs and distinguishing outputs from clutter.	View output of cross cueing to templated vehicles, evaluate outputs and sensors, and evaluate common assembly area actions and dispersal. **Exercises**: 5 + gate **Gate:** Civilian vehicles, dispersal, search patterns, sensor capabilities.	Identify and evaluate sensor outputs and activities. **Exercises**: 5 + gate **Gate**: Evaluation of R&S data collected.	Confirm templated positions and intel reports. **Exercises**: 3 + gate **Module 3 Quiz**
Module 4: Predict enemy actions (basic). Introduces dynamic retasking of sensors based on evaluation of sensor output.	Perform dynamic retasking of sensors and retask sensors based on evaluation of sensor outputs. **Exercises**: 3	Evaluate sensor outputs and retask sensors. **Exercises**: 4 + gate **Gate**: Sensor output and dynamic retasking.	Detect and identify enemy units and equipment. **Exercises**: 2 + gate **Module 4 Quiz**
Module 5: Predict enemy actions (advanced). Introduces higher level of sensor output interpretation including anticipating threat actions and use of multiple sensors for R&S matrix tasks on PIRs.	Perform dynamic retasking of sensors to track and anticipate threat actions. **Exercises**: 2 + gate **Gate:** Dynamic retasking of sensors	Evaluate outputs, cross cue and retask sensors. **Exercises**: 4 + gate **Gate:** Demonstrate the use of multiple sensors for R&S matrix tasks on PIRs.	Confirm intel reports; detect, identify, and confirm multiple moving and stationary units. **Exercises**: 4 + gate **Module 5 Quiz**

Design of the training delivery system to manage exercise presentation and sequencing, participant responses, feedback, and data collection was driven by both technical training requirements and constraints. Several features were identified early as essential for managing

the BCV 101 exercises, while other features were added as the project developed to increase both usability and training quality. The most important general delivery system features are shown in Table 5.

Table 5

Essential Battle Command Visualization (BCV) 101 Training Delivery System Features

Feature	Description and Use
Common operating system	Exercises are readily accessible for most target participants without requiring specialized equipment or software. To run the Level 1 and 2 exercises, a Windows® operating system, the web browser Internet Explorer 6, and a color monitor are needed. (Note that that the exercises could easily be modified to run under Linux/Firefox or on a Macintosh®.)
Expert performance model	Exercises portray expert performance as a way to accomplish the tasks, but not as the only way to perform.
Progress tracking	Multi-user design and the capability to track multiple user progress over multiple training sessions. Include road map across modules.
Gates (quizzes, checks on learning)	Multiple choice questions addressing the topics covered in the preceding exercises. Most questions cover knowledge or procedures, although some items are performance-based, tied to specific situations.
Remediation	Gate questions in each module are linked to specific Level 1 or Level 2 exercises in that module. Answering a quiz question(s) incorrectly transfers the participant to the corresponding Level 1 or Level 2 exercise(s) for review. Provides reinforcement of the training objectives and concepts presented in the current module.
Visual enhancement	Use of visual cues to draw attention to particular screen elements or guide correct performance. Examples include: screenshot highlighting in the training introduction, drawing indicators for Level 2 exercises, vehicle template placement indicators, and onscreen additional participant information.
Simulation feedback (intrinsic)	Use of system-generated visual cues appearing as a result of participant actions to indicate the outcome of the actions. Examples include: dynamic sensor footprints displayed during exercises to show sensor coverage. Estimates for completion of sensor tasks available to participant upon route creation. The participant receives auto alerts for sensor detections, cross cueing and sensor images.
Training feedback (extrinsic)	Text-based description and cues used to guide performance on current and completed exercise tasks. Participant is given feedback upon incorrect actions or responses with a pop-up information window in the display.
Objective assessment	Status of completed exercises, quiz scores, number of attempts and remediation exercises stored for each participant.
Participant feedback	Opportunity for the participant to provide feedback or comments on the current exercise. Comments are stored until the current exercise is complete and then sent to a designated contact via email. This feature is only available if the learner has access to properly configured local email client account and software.

The resulting BCV 101 training delivery system is referred to as a surrogate Learning Management System (sLMS). The BCV 101 sLMS provides all of the basic functionality found

in a commercial off-the-shelf LMS, such as tracking individual participant progress, managing content delivery, assessing outcomes, and providing rudimentary (i.e., not intelligent tutor-driven) feedback. The sLMS also features the ability to track the progress of multiple users across multiple training sessions on a given training PC.

However, there are significant differences between commercial LMS systems and the sLMS developed to support BCV 101. The BCV 101 sLMS is essentially client-centric, while a commercial LMS is almost always server-centric in that it is installed and run using a network server where processing takes place and data are stored. Under these circumstances a typical student is required to connect to the LMS network in order to train. The BCV 101 sLMS takes advantage of client computer resources and web browser technology, but does not require a student to connect to any network or more importantly a network server. It can be installed in a network environment, allowing the training to be delivered over a network, or can be used as a flexible "stand-alone" system, capable of running from virtually any removable media or storage type (e.g., CD-ROM, DVD, USB-drive) that is large enough to store the system and exercise files. In essence, the sLMS comprises one specific implementation of a basic LMS design, whereas commercial LMS software can typically deliver a variety of training content in various formats across a range of networks.

Development Process

The actual construction of the Level 1 and 2 exercises delivered through a standard browser-type interface required developers to capture data and images from the prototype C^2 simulation system and manipulate those data and images using a variety of off-the-shelf software packages (as shown in Table 6).

Using the prototype C^2 system, a complete screen recording was made as a military subject matter expert performed the previously developed exercises (those with Level 3 interactivity). Variants of those exercises were also performed and recorded in order to obtain unambiguous examples for specific teaching points. Recordings were translated into a format that could be edited, and those files were then compressed by removing unnecessary footage. In this way, exercise performance time was cut to about one-fourth of its original length.

The resulting multimedia files were then "chunked" into instructional segments, which were typically smaller for Level 1 than for Level 2. The chunking of instructional content conforms to guidance from cognitive processing experts on how to organize information for better comprehension and learning (Deatz & Campbell, 2001; Sanders, 2001). Text guidance was written to explain the content of the multimedia presentations, and a user interface was created that contained text guidance and participant controls as well as the multimedia presentations. The appearance and functioning of the interface is described in the next section.

Table 6

Technical Process and Applications for Development and Delivery of Level 1 and 2 Battle Command Visualization (BCV) 101 Exercises

Development Steps	Technology Application
1. Perform complete Battle Command Visualization (BCV) 101 exercises (Level 3 interactivity) and exercise variants with expert manipulation of the presentation.	Prototype C^2 simulation system with OneSAF Test Bed (OTB)
2. Record and save raw movie files of each BCV 101 exercise in Audio-Video Interleave (AVI) multimedia format.	Camtasia Studio™ Version 2.00
3. Transfer recorded AVI files to desktop computer for frame processing.	
4. Convert raw AVI movies, in whole or in parts, into editable project files and remove redundant and/or unneeded frames, frames containing errors of screen capture (e.g., semi-transparent dialogs and/or graphics anomalies).	RoboDemo Version 5.0.0
5. Convert project files into frame-specific images and export selected movie frames from each exercise recording as joint photographic group (JPG) graphic files.	RoboDemo FLASH module, FLASH Studio MX
6. Develop descriptive text and cues for the individual steps within each exercise and merge text and JPG files.	Microsoft® PowerPoint
7. Add animations of mouse movements and user actions to simulate real time use.	FLASH Studio MX
8. Review training exercises for accuracy and interactivity.	Microsoft Internet Explorer
Delivery Mechanisms	**Technology Application**
Control of sequence of exercises, feedback, remediation	HTML and JavaScript programming languages, running in Microsoft Internet Explorer 6.
Task Guidance, Task List, and C^2 Display areas of Training Interface (as described in the next section).	FLASH ActionScript

Battle Command Visualization 101 Training Program Description

The previous section discussed the research and development considerations and decisions on which the BCV 101 is based, and described the overall structure of the BCV 101 exercises for Levels 1, 2, and 3 interactivity. This section describes the training from the vantage point of the participant: what he or she sees and does during training.

On opening BCV 101 for training, the participant first views the Login screen (shown in Figure 4). If desired, the participant can choose to view the training introduction, a series of eight dynamic screens that describe the overall BCV 101 training experience and environment. At the conclusion of the introduction, the Login screen again appears.

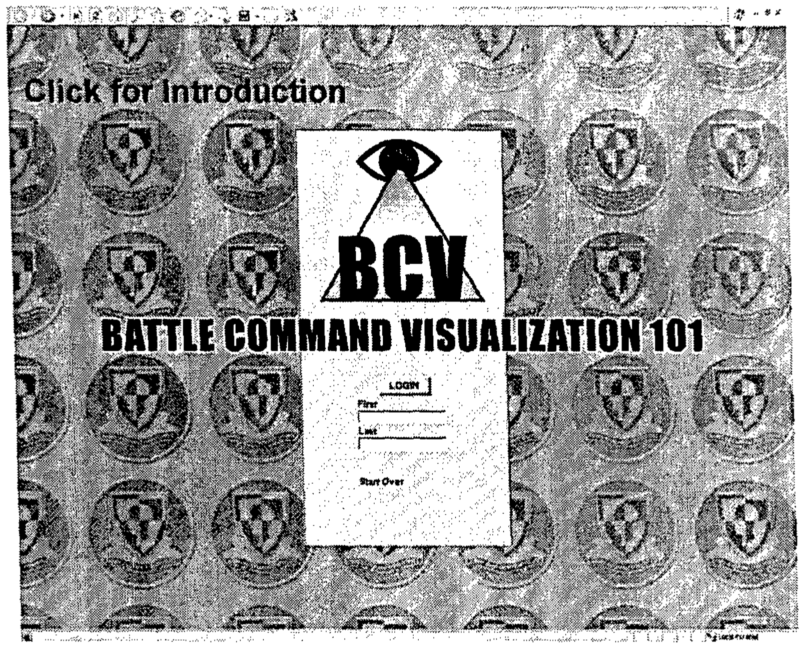

Figure 4. Battle Command Visualization (BCV) 101 Login screen.

When he/she is ready to begin the training, the participant enters first and last name. For a first time user, the sLMS uses this information to store and initialize a "cookie" on the client machine. Additional information on training progress will be stored to the cookie throughout the training. For the returning participant who has done some BCV 101 training on that PC, information which was previously stored to the cookie is read. In either case, the participant then sees the Module Selection screen (Figure 5).

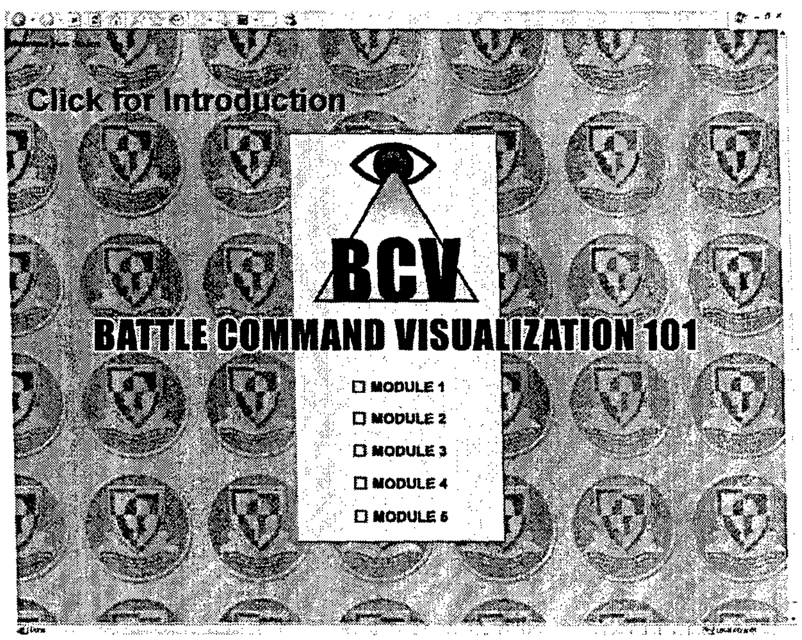

Figure 5. Battle Command Visualization (BCV) 101 Module Selection screen.

The Module Selection screen displays a menu from which the participant selects a BCV 101 training module. Again, the participant has the option of viewing the training introduction. Once a module is selected the participant sees the startup screen for the selected module.

The startup screen for each module contains a Module Map (such as the one shown in Figure 6) which displays a visual representation of that module's exercise organization, including Levels 1, 2, and 3. The title of the participant's next exercise is displayed below the Module Map; in Figure 6 the participant is in Module 1, and the next exercise would be "Draw Named Area of Interest (NAI)." The participant can "mouse-over" any exercise control button to view the title and learning objective for that exercise. The participant can select either the next exercise (shown in gold on the Module Map) or any previously completed exercise (shown in green) from the Module Map. Any exercises that are grayed-out (neither gold nor green on the interface) are not selectable. This limits access to only the exercises that have already been completed or to the current exercise. The participant cannot skip over any exercise within a module nor skip any modules, but must complete the training in the prescribed linear format. A selection is made by clicking either the appropriate control button in the Module Map or the gold "Go" arrow. Once an exercise selection is made, the participant sees the Training Interface.

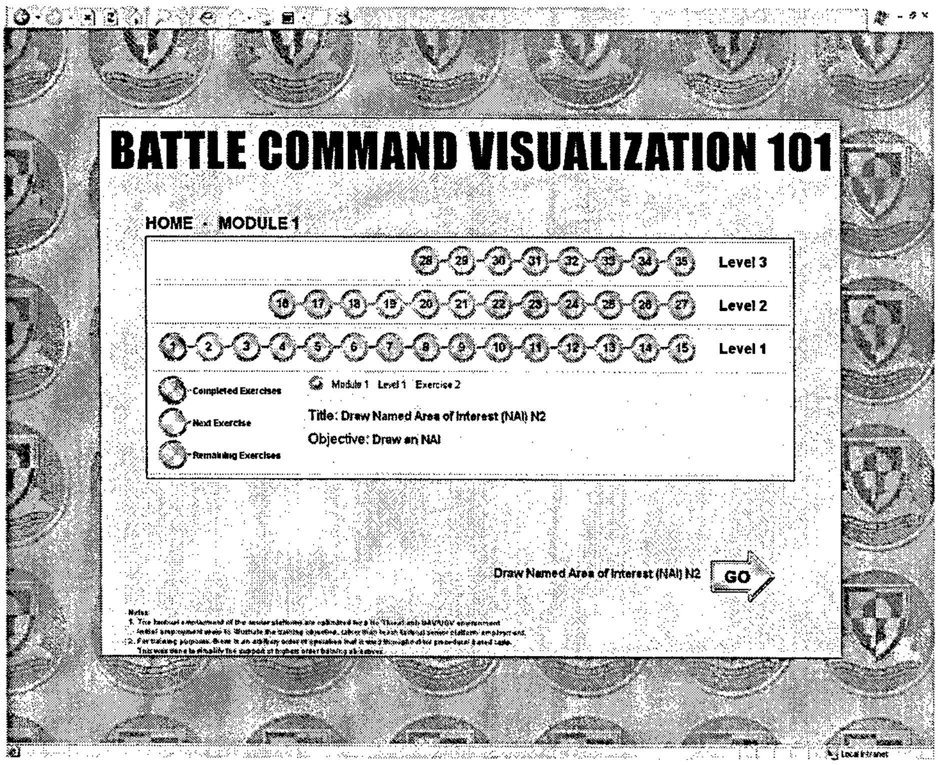

Figure 6. Startup screen with Module Map for Module 1 of the Battle Command Visualization (BCV) 101 training, showing title and objective for Exercise 2.

The participant views different features and controls on the Task Interface for Level 1 and Level 2 exercises, because of the more directive nature of Level 1 exercises and the more interactive nature of Level 2 exercises. At both levels, there are four distinct areas on the Training Interface (such as shown in the example in Figure 7): Task Guidance, Task List, C^2

Display, and Reach. Participant actions using the Training Interface are described below, first for Level 1 training and then for Level 2 training.

Description of Battle Command Visualization 101 Level 1 Training

In Level 1, the Task Guidance area, in the upper left, will draw the participant's attention first because of its position (see Figure 7). During a Level 1 exercise, when the participant observes expert performance and receives procedural instruction, the text in the Task Guidance area provides a detailed explanation of the current exercise step. This area is dynamic, that is, depending on where the participant is in an exercise, different control buttons will appear that allow participants to control their progress through each Level 1 exercise:

- *Next*—advances to the next step, which will show the detailed explanation and also bring up a new image in the C^2 Display area;
- *Back*—shows the explanation and image for the previous step;
- *Show Me*—triggers the exercise step to play in the C^2 Display area;
- *Replay*—plays the current step again from its beginning in the C^2 Display area;
- *Autoplay*—plays the exercise without breaks (available only at exercise start);
- *Rewind*—restarts the current exercise at its beginning;
- *End*—returns participant to the Module Map when an exercise is completed; and
- *Provide Feedback*—allows participant to compose and send comments about the exercise to developers by email.

For example, in Figure 7, the participant has just completed the animated demonstration of step 1 in an exercise in Module 1 (triggered by the *Show Me* control). The participant can select any of the controls except *Autoplay*. Figure 8 shows the Training Interface at the end of an exercise, when the participant has four choices: *Rewind*, *Back*, *End*, or *Provide Feedback*.

As the participant completes each step in a Level 1 exercise, the text for that step is added to the scrollable Task List area in the upper center of the Training Interface. The Task List area allows the participant to review the exercise steps in text form during or at the end of the exercise. In Figure 8, where the participant is at the end of a Level 1 exercise, all seven of the steps for that exercise appear in the Task List area.

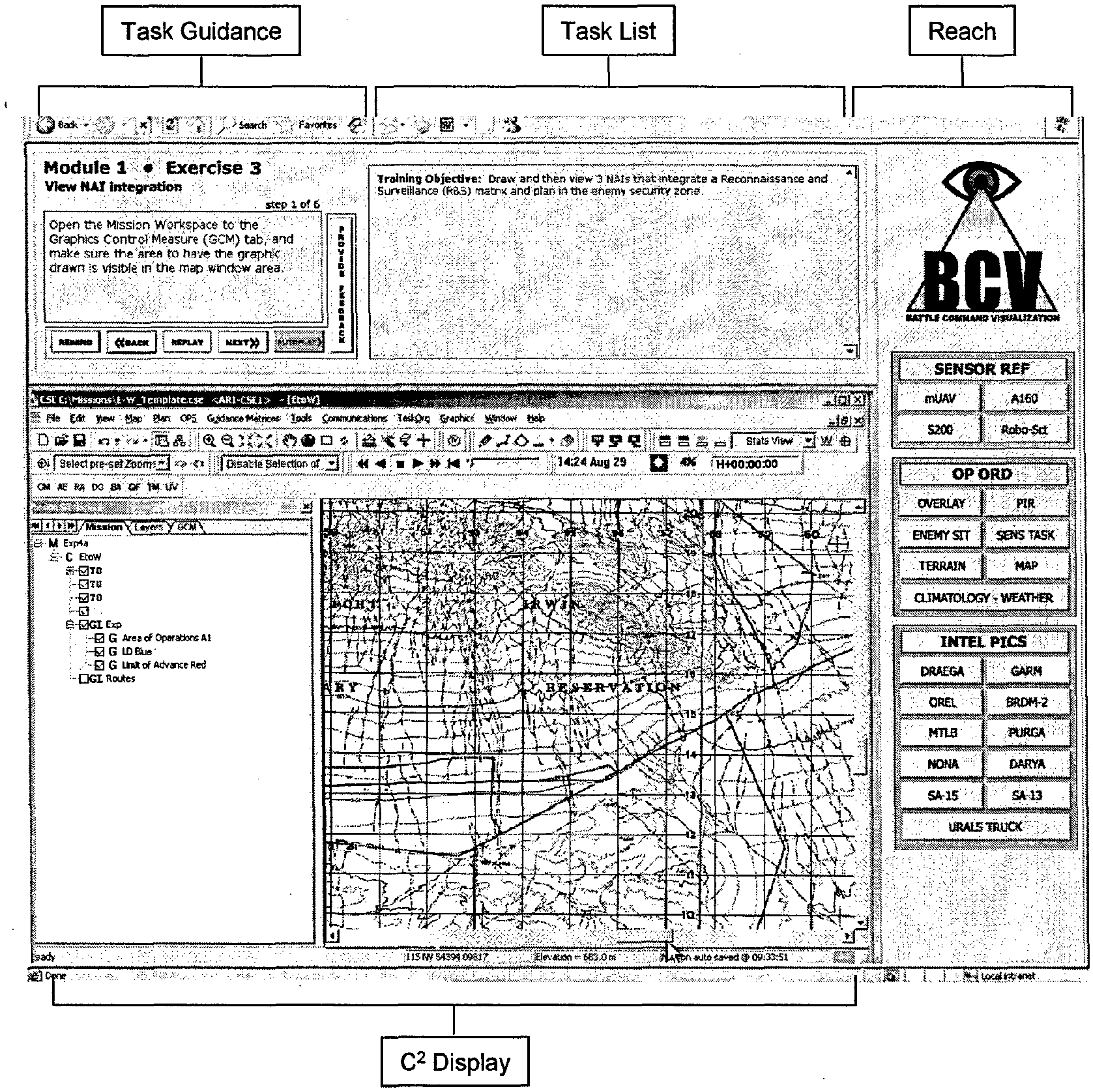

Figure 7. Example of Training Interface showing Task Guidance, Task List, Reach, and Command and Control (C^2) Display areas, at the start of Module 1, Exercise 3 (Level 1).

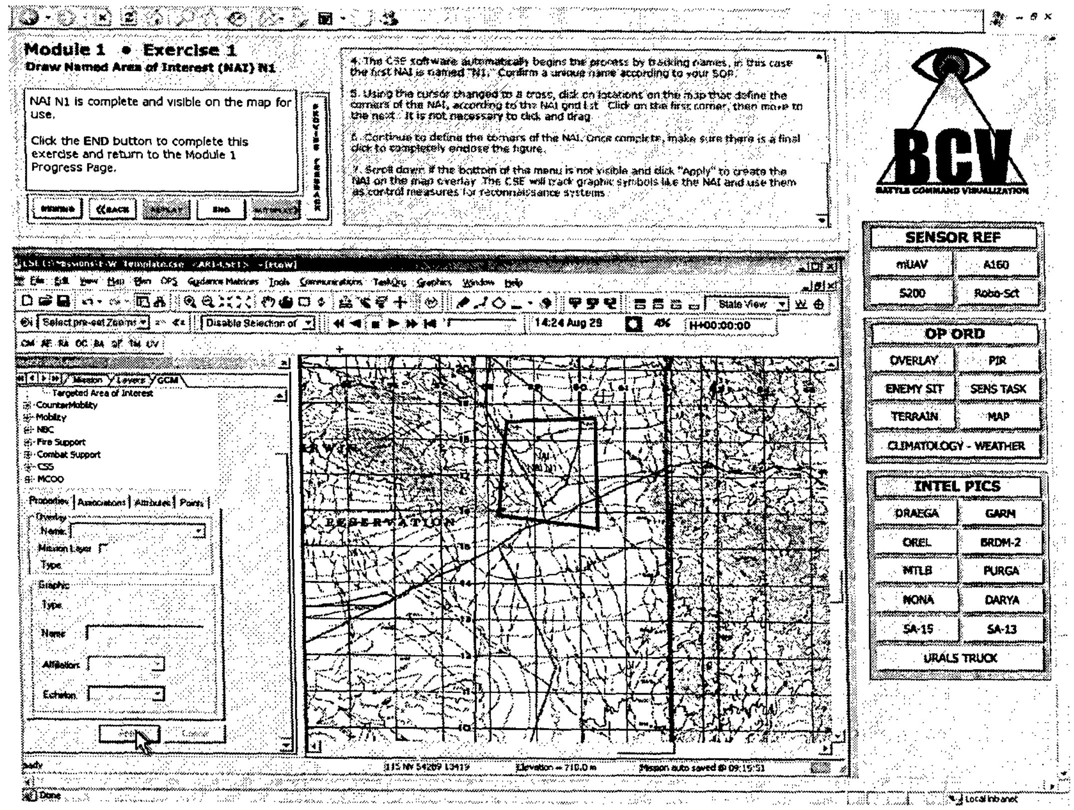

Figure 8. Example of Task Guidance area at the end of Module 1, Exercise 1 (Level 1).

The C^2 Display is the largest area of the Training Interface, and is where the participant views expert performance of task steps during the Level 1 exercise. This display area replicates the appearance of the Graphical User Interface (GUI) from the prototype C^2 system. At Level 1, the participant sees an animation of the steps that form the larger exercise. In essence, the participant is watching portions of the entire recorded exercise as separate "movies" that correspond to exercise steps. As noted above, the participant controls the progress within a Level 1 exercise using only the control buttons in the Task Guidance area; none of the C^2 Display control buttons is active. In Figure 9, showing the end of the Level 1 exercise, the C^2 Display includes the NAI that was drawn during the course of the exercise.

The participant also has access to supplemental information to support the conceptual aspects and overall training objectives by means of controls in the Reach area along the right side of the Training Interface. These links are always available to the participant during every exercise at Levels 1 and 2. The links are divided into three sections:

- *Sensor Ref*—Sensor Reference, which gives access to descriptions of sensor features and capabilities (see example in Figure 9);
- *OPORD*—Operations Orders, providing representations of all of the tactical materials for the mission (see example in Figure 10); and
- *Intel Pics*—Intelligence Pictures, which are reference representations of enemy vehicles or other objects that may be detected on the battlefield (see example in Figure 11).

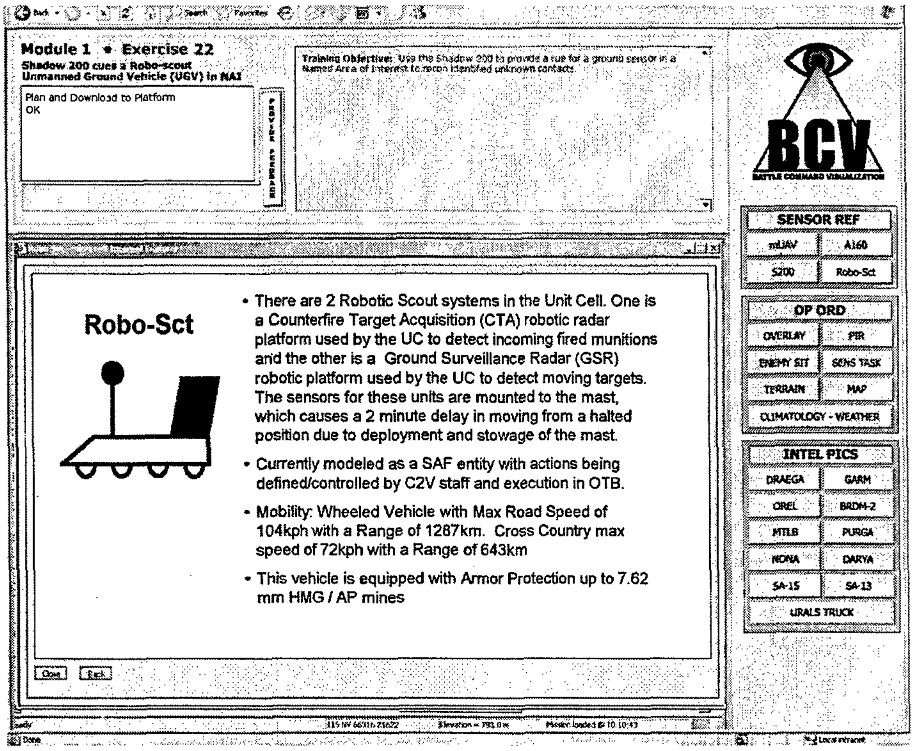

Figure 9. Example of Robo-Scout information, accessed through the *Sensor Ref* portion of the Reach area.

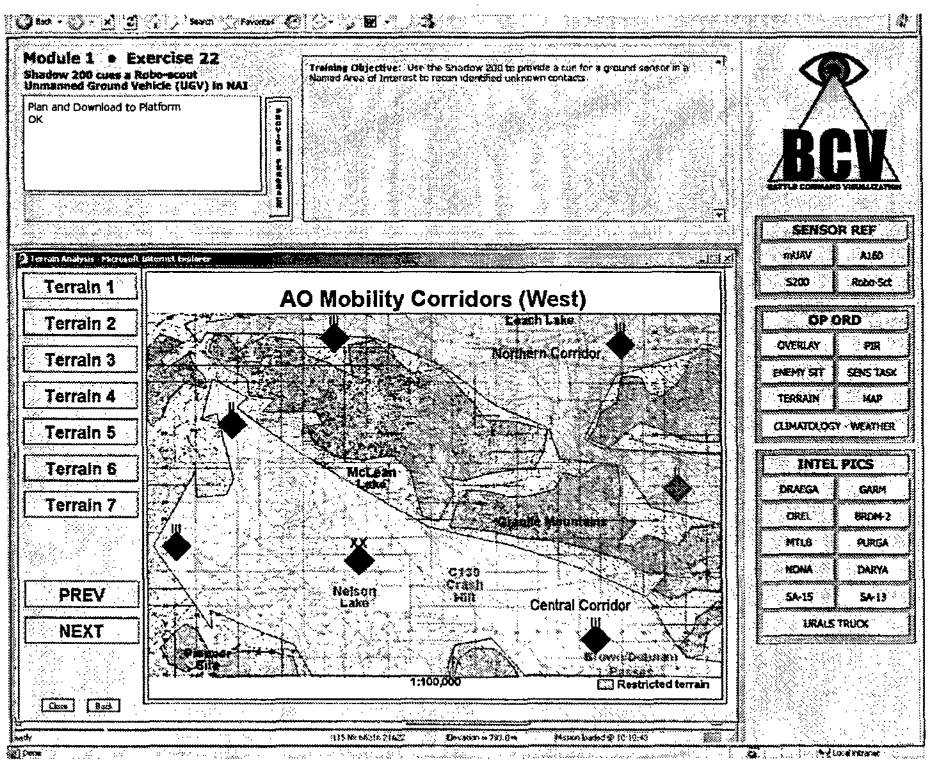

Figure 10. Example of terrain information, accessed through the *OPORD* portion of the Reach area.

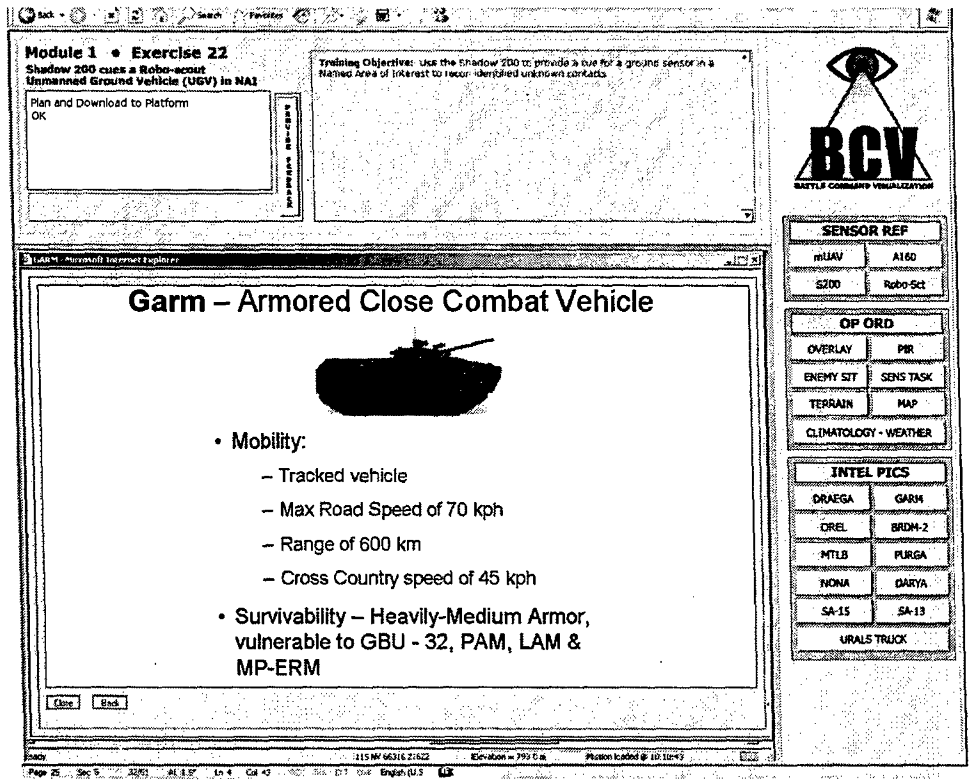

Figure 11. Example of Garm vehicle information, accessed through the *Intel Pics* portion of the Reach area.

In general, performance feedback in simulation-based training may be either intrinsic (representing what would actually occur in the real world if certain actions were taken) or extrinsic (emanating from a coach, whether automated or live). In BCV 101, the Level 1 exercises have very low participant performance requirement, and thus there is little opportunity for participants to receive either intrinsic or extrinsic feedback concerning their own performance. In the course of watching expert performance, however, they view intrinsic feedback as the system reacts to expert actions, and receive extrinsic feedback in the form of explanations of what happened.

When all steps for the Level 1 exercise have been completed, the participant is prompted to click on *End* in the Task Guidance area. The Module Map for the current Module then reappears, and the control button for the completed exercise changes color (from gold to green) to indicate that the exercise is completed.

As described previously, each module has strategically placed gates. At Level 1, the gates are referred to as Checks on Learning. Each gate contains four knowledge or performance based items (an example is shown in Figure 12). These gates, presented and performed on the PC, are multiple choice and may have either single or multiple correct answers. A participant selects his or her answers via mouse clicks and the answers are checked after all questions have been answered. If the participant answers any of the questions incorrectly, the quiz presents only those questions to the participant again. If the participant again answers incorrectly, the system redirects him or her to the corresponding exercise(s) from the current module and level for

remediation. After the participant completes the exercise(s), he or she is quizzed again. This process is repeated until all questions for the current quiz are answered correctly.

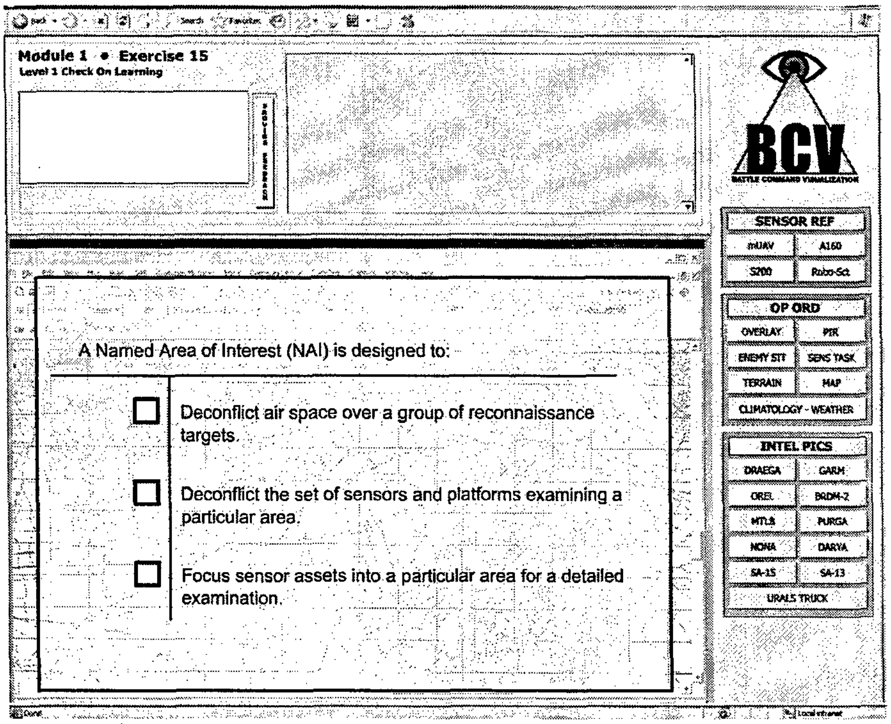

Figure 12. Example of item from Check on Learning for Exercise 15 in Module 1, Level 1.

Description of Battle Command Visualization 101 Level 2 Training

For the BCV 101 Level 2 exercises, the participant enters the training in the same way as described for Level 1, through login, module selection, and exercise selection. At that point, the Task Interface screen appears, containing the same four areas but less instructional guidance than was seen at Level 1. For example, as shown in Figure 13, the text in the Task Guidance area is only a prompt or cue for the learner to take some action to complete the current exercise step. Here, the participant has only a short prompt telling him/her to "Draw the corners of the graphic" (ROZ R1) in the C^2 Display area. Once the participant completes the step correctly, detailed text appears in the Task List area, rather than just the prompt. Control buttons in the Task Guidance area are not displayed during Level 2 exercises, because the participant must take actions on the C^2 Display to progress through and complete the exercise.

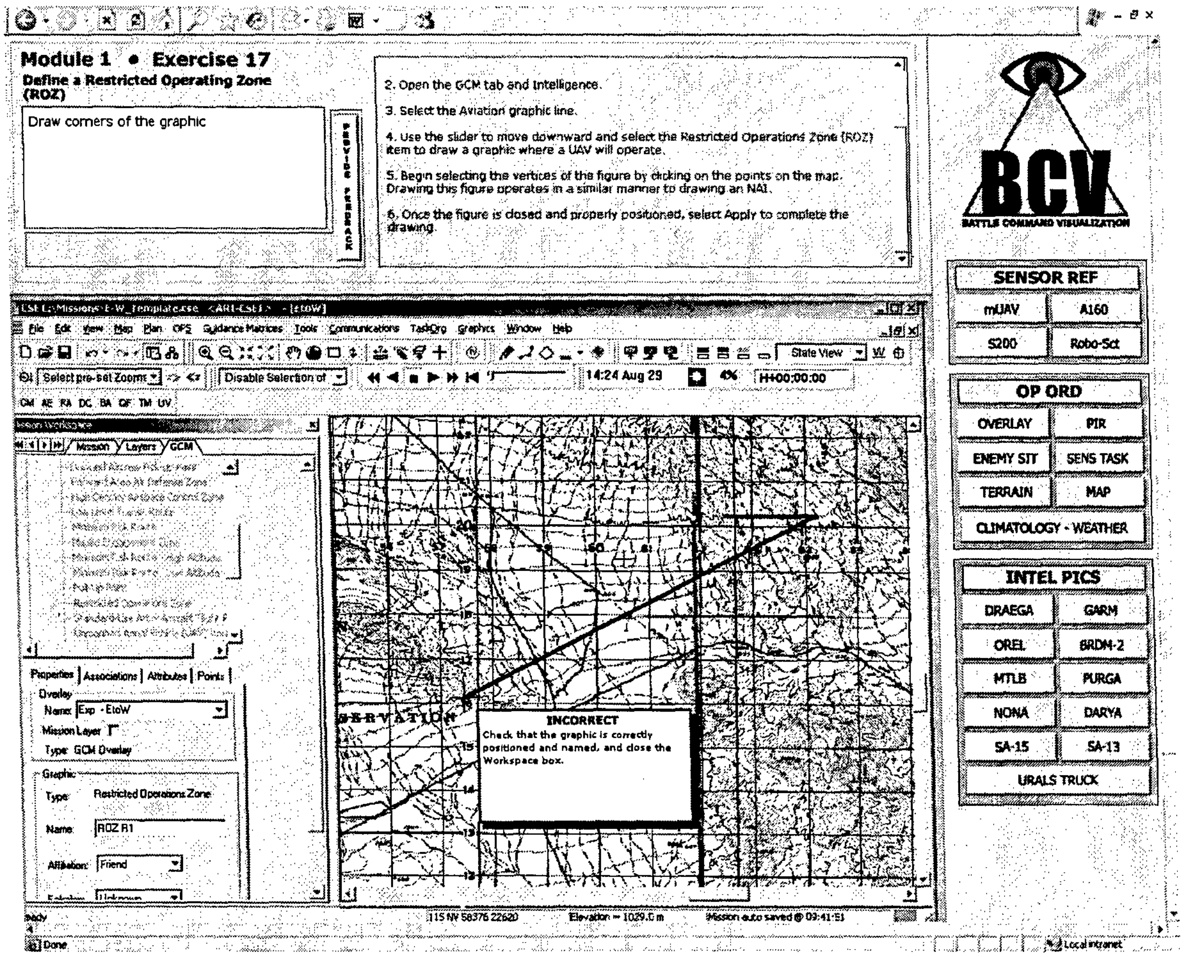

Figure 13. Example of Command and Control (C^2) Display for Module 1, Exercise 17 (Level 2) with Task Dialog box.

At Level 2, the participant responds to the cues in the Task Guidance area by performing the actions in the C^2 Display as if he/she were using the actual C^2 system through its GUI. The C^2 Display area is coded in such a way that only correct actions (i.e., a click on a tool button or menu selection) are selectable or "hot" during a step. Most of the feedback is extrinsic: incorrect actions are immediately followed by (1) "incorrect" popups with additional guidance, or (2) auto replays of the required correct action (see example in Figure 10, where the "Incorrect" Task Dialog is shown). The Task Dialog displays detailed text that describes the actions required to complete the current step. This text provides more coaching than do the Level 2 cues shown in the Task Guidance area of the Training Interface. In fact, the Task Dialog box displays detailed remediating text that is similar to the corresponding Level 1 step description. If the participant again takes an incorrect action during the current step, he or she is automatically shown a Level 1 demonstration of the correct action(s) for the current step. Correct performance is followed by appropriate system behaviors, thus providing the participant with intrinsic feedback.

Within the C^2 Display, certain visual enhancements are provided to draw the participant's attention to particular cues. (While this occurs in Level 1, it is much more prevalent and necessary in Level 2.) Figure 14 shows an example of the visual cue in the form of a pop-up

alert given to a participant when sensor cross-cueing occurs. The sensor platform routes at the top of the display in this example show where the Shadow 200 SAR platform will move during the mission, as programmed or selected by the participant. The shaded gray area in the center portion of the screen (which appears as translucent yellow on the display) shows the immediate coverage area for the Shadow 200 as it moves along the route. Once the Shadow 200 makes a detection, the C^2 Display provides the participant with diamond symbols showing the detected enemy location and a pop-up notification window. When the participant clicks "OK" on the pop-up, a pre-designated platform, such as an mUAV, is sent to that location to take a daylight or thermal optics photograph. A small red circle appears next to the diamond representing the enemy location on the C^2 Display when the photograph is ready for participant examination.

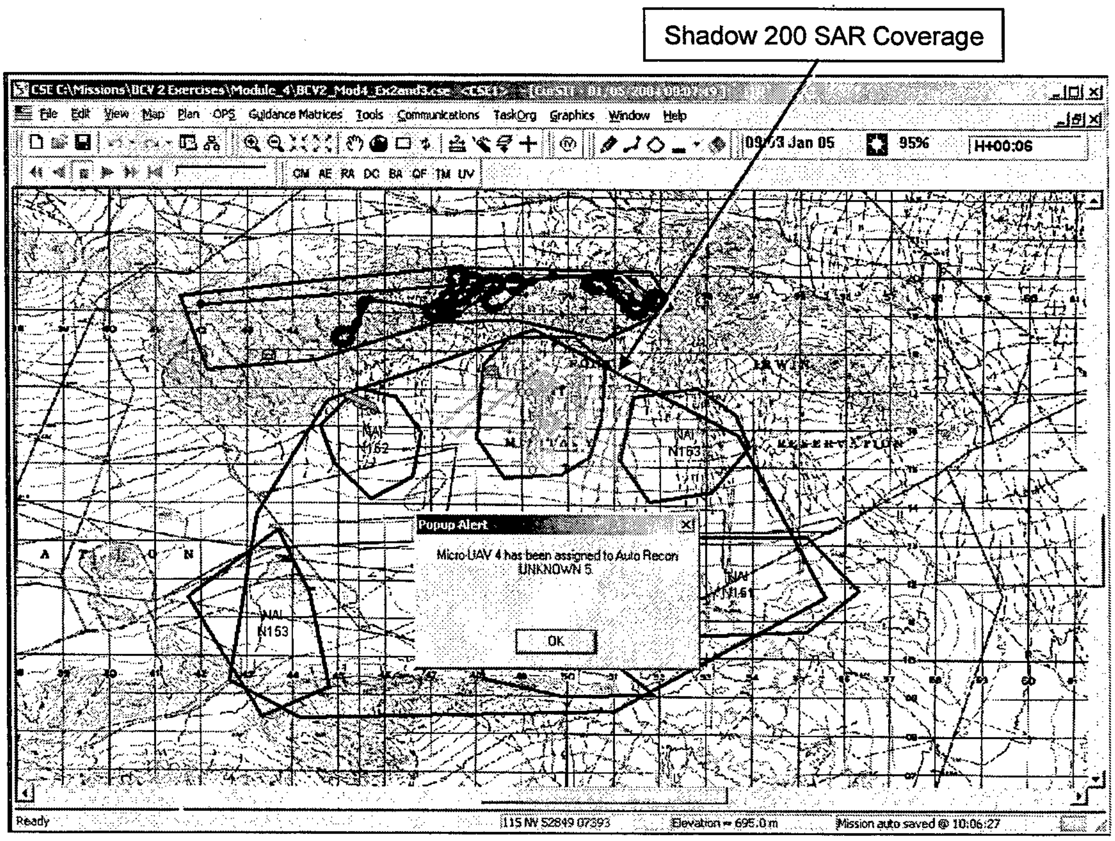

Figure 14. Example of cross-cueing notification between the Shadow 200 and micro-unmanned aerial vehicle (mUAV).

At the conclusion of each Level 2 exercise, a brief statement is presented in the Task Guidance area to remind the participant about the training objective of the exercise in relation to tactical applications with the R&S matrix and PIRs. Figure 15 shows the summary statement presented at the end of exercise 24 of Module 1, a Level 2 exercise.

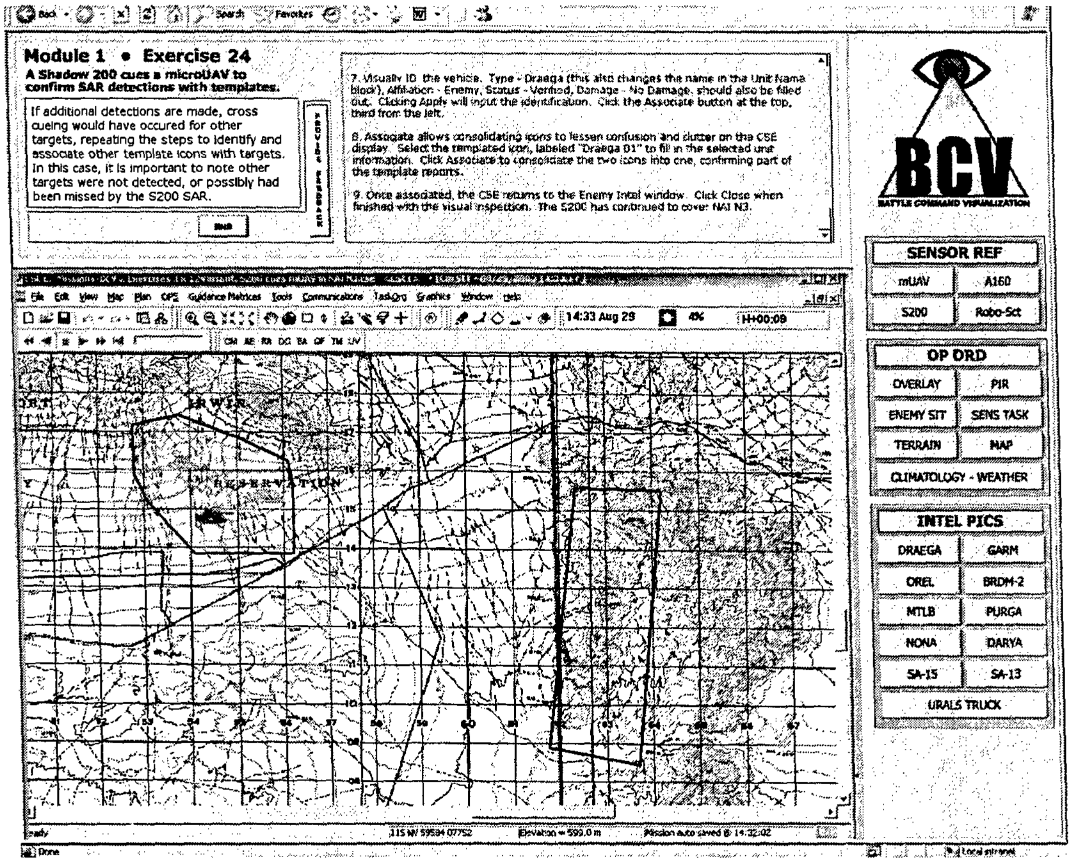

Figure 15. Example of summary statement for Exercise 24 in Module 1, Level 2.

As in Level 1, gates are presented to verify that the participant has learned and understands the content. Again, the sLMS controls remediation of incorrectly answered items by either allowing the participant to try again or sending the participant back to the appropriate exercise.

Description of Battle Command Visualization 101 Level 3 Training

After completing all of the Level 1 and Level 2 exercises in a module, the participant would then move to the prototype C2 virtual simulation system for the Level 3 exercises. These exercises are performed under the control of a live trainer, who operates the prototype C^2 system to bring up the appropriate exercises and also observes and provides feedback.

The 20 exercises developed in the previous project (with slight modifications) served as the BCV 101 Level 3 exercises. They were grouped into five exercise bundles with three to seven exercises of progressive difficulty per bundle. Exercise bundles run continuously from one exercise to the next with no break. The time to complete an exercise bundle was lengthy (approximately 35-45 minutes), but that length was necessary in order to allow enough time for sensor detections, sensor cross-cueing, sensor images received, and trainee assessment of sensor images.

Unlike the Level 1 and 2 exercises, the Level 3 exercises require a training support package (TSP) that includes printed materials to stimulate performance (e.g., the sensor tasking matrix). All exercises provided simulation-based feedback on the process and outcome of sensor employment *during* the exercise. Process feedback included visual depiction of dynamic sensor footprints or coverage areas, and outcome feedback included automated alerts and data on sensor detections and sensor images received. Feedback *after* exercises was provided by the trainer rather than the C^2 system.

More detail on the 20 Level 3 exercises and the TSP for those exercises is provided in Lickteig et al. (2004).

Formative Evaluation

Throughout the development process, continual formative evaluation (FE) was conducted by the team to test and refine linkages, screen layouts, and other features of the design. In addition, a limited try-out and review was conducted to gather additional data about the exercises, the training approach, and the expected utility of the exercises for training on a future C^2 system. Three volunteers (one military, one retired military with expertise in training and FCS, and one civilian researcher with expertise in training and distance learning) completed Module 1, Levels 1 and 2, and the first two also completed Levels 1 and 2 of Modules 2–4. While the major portion of time was spent in trying out the exercises, valuable comments on the exercise system and learning management system were also obtained. Average time for the exercises, once the individuals had built up some familiarity with the system, was estimated to be between 12 and 14 minutes (researchers tried to account for actual participation time separately from time spent discussing features and flaws).

In order to assist the FE participants in understanding the various actions they would see and perform, initial assistance was given to orient them to the tactical framework products and explanatory materials provided on the interface. Developing an understanding of the concept for using remotely controlled sensor platforms came relatively easily. During the tryouts, one participant was a player in tactical experiments in which he had to use a prototype FCS Maneuver Command and Control System. When he returned, he noted how closely the BCV 101 procedures matched the requirements for using that system and stated that the BCV 101 tryouts helped him in train-up for the experiments.

Over half of the participant comments and observations by the team during the tryouts concerned fixes or improvements that could be (and were) implemented with little difficulty. These included such suggestions as increasing the visibility of certain cues, adding explanations, and rearranging screen presentations. There were also a number of substantive comments that either validated the current design decisions or were recorded for future revisions. The most useful comments (most of which were repeated both within and across participants) are described below.

Modify sequencing and chunking of Level 1 and Level 2 exercises to allow practice closer to demonstration; focus the practice with less repetition.

Two of the participants recommended that the sequencing and "chunking" of Level 1 and Level 2 exercises be modified. One participant commented that the time between watching and doing was longer than he liked. He also felt that there was too much repetition and that the same learning could occur with fewer exercises. A shorter set of Level 1 exercises, possibly as few as 2 or 3, should be immediately followed by a Level 2 exercise on those actions, allowing practice on the actions while the information is fresh. Accomplishing this would require simply redefining the scope of the individual modules, and would result in a greater number of shorter modules covering the same scope of material.

Reexamine amount of demonstration included in remediations.

Another observation concerned the remediation process in Level 2 exercises when an action was performed incorrectly twice in a row. Currently, the sLMS shows an animation of the correct action for the step being performed. This review and demonstration is very similar to the autoplay available at Level 1. Correct performance through the entire step is demonstrated, thus giving a view of some actions yet to be performed. The participant felt that while this was a useful feature for the system as a whole, it needed work. Specifically, for the exercises in Module 1, which are relatively simple, showing the entire sequence was valuable. For the other modules, the review should only demonstrate the action incorrectly performed plus one previous action and the next action. Otherwise, it takes too long, and viewing all the other actions in the step is a distraction.

Allow participants more control of processes to manipulate C^2 interface and perform tasks.

The participants who worked through Modules 2 and 3 expressed some minor impatience with the way the exercises led them through task performance. As they gained understanding of the system, how it worked, and what it could produce, they wanted more control in the Level 2 training. They expressed a desire to zoom in on the pictures, try alternate methods of performing a task, or use control buttons other than those that were "hot," and felt the requirement to perform a task in a certain way was somewhat too limiting. In light of the comments about repetition noted above, it seems likely that learning occurs faster than anticipated, and that participants are ready for more interactivity and complexity than had been planned. It is also possible that being able to perform Level 3 exercises would satisfy their desire for more control, as well as leading them to appreciate the relative directive nature of the Level 2 exercise requirements. Neither of these hypotheses was tested.

Improve way that the C^2 Display represents multiple detections.

One participant noted an instance where a sensor detected just one vehicle, and only one vehicle icon was automatically placed on the map display; yet an mUAV photo showed three enemy vehicles. While it was clear that enemy movement, positioning or camouflage could affect the radar detection, the system only places one icon per photo on the map display. Even with a correct label that would show up during a mouse over, this could result in a false sense of

the battlefield without the ability to disaggregate and label the correct number of icons for the vehicles in the picture. A future desirable feature for the prototype C^2 system, and in the training version as well, would be the ability to disaggregate pictures into individual icons and tag those individual icons with portions of pictures. This subject came up in several exercises with multiple vehicles in a photo and could help reduce confusion when vehicles are in close proximity. As FCS UAVs and UGVs are further developed, and the capability for sensor fusion is achieved, that same capability will need to be represented in the training systems. This is, of course, a human factors issue more than a training issue, but bears mentioning.

Retain Level 2 exercise summaries as reminder of "big picture."

At the end of each Level 2 exercise, a brief statement is presented to remind the user about the purpose of the exercise in relation to tactical applications with the R&S matrix and PIRs. One participant noted repeatedly that he liked this summation as a way of tying together mission tasks with the tactical framework and the required performance of the exercise. He saw this as a way to keep the participant thinking tactically about the use of the sensors and how they fit into the larger picture.

Conclusions

The U.S. Army has identified the need to provide ET in operational vehicles and systems, and to develop a complementary mix of training methods best suited to a wide range of current and future training requirements. In support of that need, the training methods developed demonstrate practical and innovative ways to train the Current and Future Force. The primary finding of the research is an innovative training approach that extends the delivery of high-fidelity training; it is not the BCV 101 training product per se. In fact, the FCS sensor and C^2 systems as well as the ET addressed in the training of BCV 101 do not yet exist, and will not for quite some time. The use of high-fidelity source materials in the training approach counters the traditionally inverse relationship between training fidelity and availability.

The fidelity required to "train as you fight" is the primary objective of ET, and it is also the primary challenge. For example, full-fidelity ET requires that FCS vehicles provide a training mode that uses all vehicle instruments, controls, menus, and screens just as they are used in the operational mode. Responding to that objective, the high-fidelity source materials of BCV 101 feature an expert trainer using a C^2 system to employ sensors on a simulated battlefield in order to provide realistic training at IMI Levels 1 and 2. This high-fidelity approach allows training participants to directly visualize and control the actions and interactions of prerecorded networked systems as simulated in a dynamic operational setting. The ability to widely deliver such high-fidelity materials is a rich and powerful source for the training feedback essential to performance improvement.

For BCV 101, high-fidelity source materials provide intrinsic feedback during each exercise that includes how the *C^2 system* responds to the human interactions that employ the sensors. It also includes how the *sensors* respond to human tasking. How different types of sensors maneuver over the battlefield and detect, or fail to detect, targets depending on enemy type and location. Intrinsic feedback also includes how a simulated *FCS network of systems*

responds to one another, including sensors cross-cueing other sensors to continue surveillance as well as sensors cross-cueing shooters to selectively engage detected targets. Unlike mere simulation, the BCV 101 approach couples high-fidelity with principled training in a progressive matrix of gated exercises integrated by a common and purposeful tactical framework.

Unfortunately, higher levels of training fidelity typically limit availability. A pivotal example is that full-fidelity ET for a mounted force, by definition, will be available only when its Soldiers are physically onboard their operational systems. Similarly, IMI Levels 3 and 4 often require a technical infrastructure, such as a COFT or CCTT simulation site, that severely limits training availability. An imperative implication of this tradeoff is that despite the anticipated potential of ET, the Army cannot rely solely on ET. Rather, a mix of alternative training methods is needed for many reasons including responding to new and unforeseen conditions, overcoming degraded modes, and especially delivering realistic training to an increasingly distributed audience. However, alternative training methods at IMI Levels 1 and 2 are commonly low-fidelity approaches that fail to provide realistic systems and settings to, or demand realistic performance by, the training participants.

In contrast, the BCV 101 approach markedly increases the Army's ability to deliver high-fidelity training at IMI Levels 1 and 2. It creates and packages more realistic training for essentially unlimited computer-based or web-based delivery. As a result, the BCV 101 approach provides an important complement to ET that readily extends to a wide range of conceptual and procedural skill training requirements. And quite unlike the ET of the future, today the BCV 101 approach can deliver high-fidelity training on computers at home, at home station, or onboard operational systems of the Current Force wherever deployed.

Another important goal of BCV 101 is to share training lessons and implications of relevance to ET and the Army's training efforts. These lessons and implications are documented in a companion multi-media product (Fisher, et al, in preparation). Their documentation is intended for training developers, system developers, decision makers, and others involved in the Army's ongoing research and development to combine training theory and technology. Overall, the BCV 101 approach, methods, lessons, and implications add to the growing body of work by ARI focused on training development for ET and FCS (e.g., Burnside & Throne, 2004; Campbell & Holden, 2001; Campbell, Throne, Black, & Lickteig, 2003; Carnahan, Lickteig, Sanders, & Durlach, 2004; Gossman, in preparation; Shadrick, Lussier, & Hinkle, 2005; Throne & Burnside, 2003).

More than usual, the proverbial conclusion that "more research is needed" applies to ET. Achieving ET is a difficult task requiring sustained research and development. One product of that research is BCV 101's exemplary approach toward developing the ET of tomorrow as well as providing the realistic and readily available training needed today. The BCV 101 effort focused on the employment of networked sensors to show how the training approach applies to tactical and technical skills that are hard to acquire and increasingly critical to both the Current and Future Force.

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Appendix A

Acronyms

AO	Area of Operations
ARI	United States Army Research Institute for the Behavioral and Social Sciences
AVI	Audio-Video Interleave
BCV	Battle Command Visualization
C^2	Command and Control
CCTT	Close Combat Tactical Trainer
CECOM	Communications-Electronics Command
CITT	Commander's Integrated Training Tool
COA	Courses of Action
COFT	Conduct of Fire Trainer
CoM	Center of Mass
D2T2	Desktop Digital Tactical Trainer
DA	Department of the Army
DARPA	Defense Advanced Research Projects Agency
DoD	Department of Defense
EP	Embedded Practice
ET	Embedded Training
FBCB2	Force XXI Battle Command Brigade and Below
FCS	Future Combat Systems
FE	Formative Evaluation
FM	Field Manual
GUI	Graphical User Interface
IETM	Integrated Electronic Technical Manual
IMI	Interactive Multimedia Instruction
INFOSYS	Information Systems
JPG	Joint Photographic Group
LMS	Learning Management System
MTI	Moving Target Indicator
mUAV	Micro-Unmanned Aerial Vehicle
NAI	Named Areas of Interest
NLOS	Non-Line-of-Sight

NRFTT	Networked Reconfigurable Full Task Trainer
OPORD	Operations Order
OTB	OneSAF Test Bed
PC	Personal Computer
PDA	Personal Digital Assistant
PIR	Priority Intelligence Requirements
R&S	Reconnaissance and Surveillance
REP	Recognize-Edit-Produce
ROZ	Restricted Operating Zone
SAR	Synthetic Aperture Eadar
SCORM	Shareable Content Object Reference Model
sLMS	Surrogate Learning Management System
TRADOC	United States Army Training and Doctrine Command
TSP	Training Support Package
TTP	Tactics, Techniques, and Procedures
UAV	Unmanned Aerial Vehicle
UGV	Unmanned Ground Vehicle